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Report of the

ACMRR WORKING PARTY ON THE MANAGEMENT OF LIVING RESOURCES IN NEAR-SHORE TROPICAL WATERS

Advisory Committee on Marine Resources Research (ACMRR)

Rome, 28 February to 4 March 1983

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ADVISORY COMMITTEE ON MARINE RESOURCES RESEARCH (ACMRR)

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Rome 1983

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PREPARATION OF THIS REPORT

This is the report of the ACMRR Working Party on the Management of Living Resources in Near-shore Tropical Waters, held in Rome, 28 February - 4 March 1983, as approved by the Working Party on 4 March 1983. Annexed to this report are selected and revised working papers presented to the meeting. The working paper from ICLARM is included under the authorship of Pauly and Smith.

Distribution:

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ABSTRACT

The problems facing fisheries of the inshore waters of the tropics are now often those of heavy fishing of limited resources. These problems arise from greater use of more effective fishing methods, and the pressure of ever-growing populations. The fisheries may be managed using a selection of the methods already familiar in temperate waters, but catch quotas are likely to be less useful, and more emphasis is likely to be placed on closure of belts along the coast, especially to reduce conflict between different types of fishing gears. It is particularly important to take action to control the fishery early, before over-capacity develops. While investment in shore facilities, for better handling and distribution of the catch, will usually be beneficial, investment in additional catching capacity should be looked at carefully. Stock assessment methods developed in temperate waters are applicable, at least to a useful first approximation, also in tropical waters, though use of length-structured models, and of comparisons between areas of similar ecological characteristics, are likely to be particularly useful. High priority should be given to applying these existing methods to provide advice to managers. For this reliable data are essential. Both analysis and data should include the economic and social aspects of the fishery.

CONTENTS

		Page
1.	OPENING OF THE MEETING AND ADOPTION OF THE AGENDA	1
2.	REVIEW OF EARLIER DISCUSSIONS	1
3.	IDENTIFICATION OF MANAGEMENT PROBLEMS	1
4.	APPROACHES TO MANAGEMENT	2
5.	USE OF TRADITIONAL STOCK ASSESSMENT METHODS	4
6.	PRODUCTIVITY OF MAJOR HABITATS	6
7.	INTERACTIONS BETWEEN FISH STOCKS AND OTHER ACTIVITIES	7
8.	OTHER APPROACHES TO ASSESSMENT	8
9.	FISHING METHODS	9
10.	SOCIAL AND ECONOMIC FACTORS	10
11.	ADVICE TO MANAGERS	11
12.	DATA NEEDS	12
13.	FUTURE RESEARCH	14
14.	ADOPTION OF THE REPORT	15
15.	FUTURE ACTIVITIES OF THE WORKING PARTY	15
16.	REFERENCES	16

APPENDIX 1 - Agenda	17
APPENDIX 2 - List of participants	18
APPENDIX 3 - List of documents	19
APPENDIX 4 - Terms of reference	20
APPENDIX 5 - Flow chart of research and management pathways in tropical near-shore fisheries	21

SELECTED PAPERS:

ECONOMIC INFORMATION NEEDS FOR SMALL-SCALE FISHERIES MANAGEMENT, by R. Willmann	23-35
THE RESEARCH PROCESS AND COMMUNICATION OF RESULTS: LESSONS LEARNED FROM A MULTIDISCIPLINARY ANALYSIS OF A TROPICAL SMALL-SCALE FISHERY, by D. Pauly and I.R. Smith	37-55

CONTENTS (cont.)

Page

A BRIEF REVIEW OF BRAZILIAN NEAR-SHORE FISHERIES,
by S. Jablonski 57-71

FISHERIES RESEARCH AND MANAGEMENT STRATEGIES IN NIGERIA:
A CASE STUDY, by T.O. Ajayi 73-78

1. Opening of the meeting and adoption of the agenda

The participants at the meeting were welcomed by Dr. A. Lindquist, Director of the Fishery Resources Division. He noted that three of the members of the Working Party had not been able to attend. The absence of Dr. Hongskul was due to sudden illness, and the meeting asked Dr. Lindquist to send a message of sympathy to him with wishes for an early recovery.

The draft agenda, as circulated before the meeting, was adopted; this is given in Appendix 1. The list of those attending, and of the documents made available to the meeting, are given in Appendices 2 and 3 respectively.

2. Review of earlier discussions

Dr. Lindquist, in his opening remarks, referred to the discussions in ACMRR that had preceded the establishment of the Working Party. These had laid emphasis on the importance, in social, economic and nutritional terms, of the inshore fish resources, to millions of small-scale fishermen in developing countries. These fisheries were now facing difficult problems, due to increased pressure on limited resources. The scientific and administrative techniques for tackling these problems have been developed in the large-scale industrial fisheries of temperate waters, and cannot easily be applied directly to the fisheries in tropical inshore waters. These latter fisheries have been discussed at some earlier meetings, e.g., at the University of Rhode Island in September 1979, and at an ICLARM Workshop in Cronulla, Australia in January 1981. The proceedings of these meetings, which were made available to the meeting, were perhaps more successful in pointing out the problems, and clarifying the issues than in recommending specific solutions. The present meeting was therefore timely. It was particularly timely in that it could provide an input on a critical subject, to the FAO World Conference on Fisheries Management and Development, scheduled for May 1984, with a technical phase in October 1983.

3. Identification of management problems

Case studies were presented (Working Papers 3, 4 and 5) describing the coastal fisheries of Brazil and Nigeria, and also the fisheries of San Miguel Bay in the Philippines. Information on other West African fisheries was presented in Information Papers 9-12. From these it was clear, not only that the problems of tropical inshore fisheries differed from those of temperate waters, but there were differences between countries, and even within countries. Information Paper 11 emphasized the great variability of the inshore fisheries of Senegal. The canoe fishermen are highly mobile, so that a single snap-shot picture of the fishery at a particular moment can give a very incomplete impression of the whole fishery. It would be wrong to believe that there was a simple problem, still less that there would be a simple solution to the problems.

One difference between several of the tropical inshore fisheries examined and many temperate fisheries is that of scale. The traditional studies of temperate marine fisheries - inland fisheries may be different - deal with large-scale matters, e.g., the plaice fishery of the North Sea, or the halibut fishery of the Northeast Pacific. A large-scale approach may also be necessary in some tropical areas, e.g., the sardinella fisheries of West Africa, where the fish - and often the fishermen - move over long distances. In other cases, such as the San Miguel Bay fishery, it may be possible to look at a relatively small area as providing a unit stock, which in turn supports a unit fishery. Similar situations, of unit stocks in bays or lagoons, or on coral reefs may be quite common in the tropics. They favour the intensive, in-depth study of selected fisheries, as opposed to the more conventional broad view of the entire national fishery. The rationale of such an approach, discussed in detail later, is that the results of an in-depth study can be readily extrapolated to other, similar areas. This is true for example of the interraction between trawlers and artisanal gear noted in the San Miguel Bay study.

The problems of tropical fisheries, as those of most fisheries, are usually complex, comprising social and political issues, as well as biological ones. It is unlikely that the objectives of management can be described solely by the maximization of some simple quantity - sustainable yield (to give MSY), economic yield (to give MEY), etc. In practice the best the manager can hope for is to reduce some of the bad features of uncontrolled fisheries so that a managed fishery is in a less bad state than an unmanaged one.

In the past the usual key to solving the problems of the inshore fisheries was believed to be 'development' - introducing better boats and better gear, giving the small-scale fishermen better access to credit so that he can invest in these more powerful techniques, etc. Taking the world as a whole this is no longer the case. There are still many areas - especially where the human population density is low - where 'development' of this kind will produce more fish, and at least for a period, solve the problems. There are even more places where upgrading the use made of fish (better handling, processing and distribution) could increase the income of the fishing community, and the contribution of fish to nutrition. This again, however, only postpones the central problem rather than solving it.

The central problem is that in many, if not most tropical inshore areas of the world, the stocks are heavily exploited, particularly off densely inhabited coasts. Too many fishermen are chasing too few fish, with the result that individual income is low, and the stocks, at least of certain preferred, or vulnerable species, are threatened with depletion. This problem has become particularly acute in those near-shore areas where small shrimp trawlers operate in competition with other gears.

There was some discussion on the relative contributions of increasing population, and the introduction of inappropriate technologies, or imperfectly controlled new technologies, to the problem. It was pointed out that the rate of increase of fishing capacity following the introduction of a new technology usually far exceeded the rate of increase in fishing effort due to population increase. The urgency of the problems therefore arises mostly from technological improvements. In the long run, however, population increases may play an equal or more important part. First, the increasing national demand for fish (which can also arise from increasing individual incomes) puts pressure on governments to approve "development" projects solely intended to increase catch, irrespective of the state of the resources, and, by maintaining or raising prices, attracts or keeps fishermen in the fishery even when catch rates (by weight) are falling. Second, so long as the growth in population is not matched by equal growth in employment in the cities or in agriculture, there is likely to be a drift into fishing as an "employment of last resort." This effect is however often modified by local customs and traditions.

The main objectives of management included a reduction of conflict between user groups (especially between artisanal and industrial fishermen), equity (especially improving the condition of the poorest fishermen), and preservation of the resource. The meeting believed that the preservation of the resource should receive priority because it is the objective that can be readily understood and accepted by fishermen. Without a resource there could be no fishery, and therefore maintaining the resource was a necessary, but not sufficient, condition for good management. Also, as already noted, the complexities of objectives imply that the optimization of any single quantity cannot be used as the sole criterion of successful management.

4. Approaches to management

In introducing this topic several papers were presented. Working Paper No. 6 by Willmann focused the management issues on distribution aspects and emphasized that maxima (MSY, MEY) were not realistic objectives for management. The avoidance of severe ecological, economic and social inbalances, a reduction of conflicts between competing sections of fishermen and considerations of income distribution are more realistic objectives. The paper concluded that in countries with high population

growth and a lack of alternative employment opportunities a re-allocation of resources from industrial to artisanal fishermen and preventing the introduction of labour-saving technologies are possible immediate measures which bridge the gap between rapidly growing numbers of fishermen and already heavily exploited tropical near-shore resources. In the long run, policies are required, which reduce the population growth, provide alternative employment opportunities and limit fishing effort through either economic disincentives in the form of taxes, price controls etc. and/or through direct management measures (limits on numbers of craft and gear etc.), which in widely dispersed artisanal fisheries can only be enforced with the cooperation of the fishermen.

The papers already referred to under item 3 (Working Papers 3, 4 and 5 and Information Papers 9-12) giving case studies in different regions, brought out the practical difficulties in applying control measures in artisanal fisheries. Emphasis has tended to be given to reducing conflict between small-scale and industrial fisheries (particularly trawlers). A common measure has been the prohibition of trawling in a belt from the coast out to some specified distance or depth.

The conclusions of the Expert Consultation on the Regulation of Fishing Effort, held in Rome from 17-26 January 1983 were presented in Information Paper No. 14. This reviewed in detail the various approaches that could be used in controlling the amount of fishing, and some of the practical experiences in using these approaches, particularly in the industrial fisheries of northern temperate waters.

The meeting concluded that of the techniques reviewed, total allowable catches and quotas were discounted as useful techniques for near-shore fisheries. A number of methods, particularly mesh size, size of hooks, etc. which do not directly control the amount or intensity of fishing were considered to be useful, but it was recognized that in many cases where over-exploitation of the resource occurs, excessive fishing effort is the prime problem and indirect measures do not resolve this. In many tropical near-shore waters for which fishing is the occupation of last resort, population growth, which together with technological improvements is causing excessive fishing effort, is the critical long-term problem and cannot be solved within the fisheries sector alone. Alternative employment (especially within the rural community) needs to be found. Attempts to dampen the effect of increasing fishing pressure through indirect methods, e.g., controls on fishing time or gear, cannot be expected to resolve the problem even from a conservation point of view. This aspect was re-inforced with the summary presentation of Information Paper No. 22 on Morocco where scientific evidence was presented to show that areal and seasonal closures would not be effective for preserving adult spawners, though they may be useful in protecting juveniles. Nevertheless it was pointed out that many of these measures are supported by fishermen, and their views should be heeded in order to elicit support from fishermen for the overall management programme.

In principle, areal or seasonal closures to certain types of gear offer a good method of reducing the conflicts between gears caused either by competition for fish, or through damage to passive gears (pots, gillnets, etc.) by active gears (especially trawls). As already noted the closure of coastal belts to trawling (or to trawling by vessels above a given size) is a widely used approach, but is rarely effective on its own in providing much protection. It was pointed out however that more specifically delimited areas (e.g., estuaries, partly enclosed bays) may be more effectively reserved for the use of less destructive types of gear.

In most tropical areas the shallow waters near the coast are much the most productive, and, especially when catch rates are depressed by heavy fishing, there is a great incentive for trawlers to work close to the shore in order to maintain a decent catch. In some areas the conflicts between trawlers and other gears are becoming so severe and the level of infringement is so high that effective enforcement is becoming impossible. The meeting believed that effective protection of the less mobile fishing gear needs more than just the legal closure of a coastal belt. For example it was suggested that there should be direct control over the number of

trawlers. This could increase catch rates, and so reduce both the need to fish in the more productive coastal belt, and the likelihood of conflict.

In discussing direct control over numbers of fishing units as a necessary tool for managing certain fishing gears in certain types of fisheries, reference was made to the publication by Johannes (Information Paper No. 7). This paper noted that certain areas of the Pacific have had long-established mechanisms for management where access was controlled, and the species harvest determined by quantity, time and by individual. These systems may however prove fragile when the system moves from a stable subsistence situation to an expanding cash economy, or when population increases or new technology lead to more pressures on a limited resource.

In times of population increases the only long-term solution to over-fishing and low incomes is to remove fishermen from fisheries through the provision of education/ training for other occupations. It must be recognized that a fixed fish resource cannot provide adequate income and employment to an ever-expanding population.

Taxes and other fiscal devices can be used as incentives or disincentives to modify the pattern of fishing in the desired direction. Thus in Iceland what is in effect a tax on cod, and a subsidy on redfish helps move the fishing effort from cod (which is too highly fished) to redfish (which is relatively lightly fished). In the Maldives fiscal measures on the export of tuna are used to discourage too high levels of fishing effort. It was felt that special conditions - a small community with most of the catch being exported - were needed to make this method practicable. These conditions might apply in some of the tropical shrimp fisheries, where an export tax might help discourage excessive effort.

Development of lightly fished stocks can help solve some of the problems of managing heavily fished stocks. To the extent that effort can be switched directly from one fishery to another this is certainly true. Often, though, measures to develop a new fishery result in the creation of new fishing units, and in the long run the result may be just to spread the problem wider. At best, diversion of excess effort to new resources can only offer a temporary respite to the problem. The benefits could however be long-lasting if the respite is used to tackle the basic causes of excess effort, and to introduce effective controls.

In conclusion, whatever technique was used, the key to success was the support of the fishermen themselves. The most promising techniques were those which were largely self-enforcing through the participation of the fishermen.

5. Use of traditional stock assessment methods

Nearly all the stock assessment methods have been developed for the industrial fisheries of the northern temperate waters. These fisheries differ from the tropical inshore fisheries in many respects - the number of species, the typical life-span, the availability of good data on catches and fishing effort, etc. Doubts have often been expressed as to the value of applying traditional methods to tropical fisheries. The Working Party felt strongly that these doubts were often inappropriate and to the extent that they inhibit any attempt to make quantitative assessments of the resources, could be definitely harmful.

This did not mean that the meeting believed that the traditional methods and models gave a perfect representation of events. Far from it. Even in the fisheries for which they were developed, e.g., in the North Sea, further research, and the demands to give more detailed and precise advice on management, have shown that the traditional models provide only a partial explanation of what is happending. The point that has to be stressed is that this partial explanation is much better than no explanation at all. The urgent problems of tropical inshore fisheries mean that managers (directors of fisheries) need advice today on the possibilities (or lack of possibilities) for expanding catches, or on the consequences of alternative management

measures (using larger mesh sizes, closing certain areas, prohibiting certain types of gear, etc.). The only way the scientists concerned can provide this advice is in most cases by using the traditional approaches - production models, yield per recruit models, etc. The fact is that these traditional approaches could work better in some tropical fisheries than in the regions for which they were developed. The short life span of many species means that production modeling using annual sets of catch, effort or mortality data in, say, the Java Sea, will come closer to representing the equilibrium situation than in the North Sea. Again the communities lying above the thermocline in equatorial areas, e.g., the Gulf of Guinea, have shown sufficient stability in recruitment and production to justify advice based on yield-per-recruit models. More complex, and more realistic stock assessment models, are being developed (e.g., the multi-species models of the North Sea, or the Bering Sea), but these are a very long way from being suitable for applying directly to tropical inshore areas. In these areas the more urgent need is to integrate stock assessment studies with economic and social studies.

The meeting was therefore concerned that despite the need for assessment advice, and the existence of data from which at least simple assessments could be made, traditional methods are often not being applied. The scientists concerned should be given every encouragement to attempt such applications, and thus give the managers advice on the resources.

The ability to apply traditional methods to tropical fisheries has been increased by recent modifications to the techniques involved (see for example FAO Fisheries Circular No. 729 by Pauly (1980). These include more use of length-structured than age-structured methods. The ability to use daily rings on otoliths needs to be explored further, and estimation of natural mortality from consideration of the biological characteristics of the fish (e.g., Caddy and Sharp in Working Paper No. 8), and using mortality rates rather than effort data in applying production models (Csirke and Caddy 1983).

The lack of comprehensive effort data was perceived as one of the major obstacles to direct application of some of the traditional models. However, it was stressed that, providing data on total catch was available, statistics of total effort were less important than having data on effort and corresponding catch for a sector of the fishery in which the fishing efficiency is not changing. This may in fact be easier to do for some traditional artisanal fishery, than in the industrial fisheries of the developed world, in which fishing technology is changing rapidly.

While stressing the importance of applying traditional methods, the meeting also stressed the danger of blind and uncritical application. The models were developed against a background of a broad general understanding of the biology of the fish and the operation of the fishery to which they were applied. Unless there was a similar general understanding of the tropical fish and fisheries, the arithmetical calculations involved in model application could result in nonsensical answers. This understanding could be assisted by producing simple diagrams, e.g., of the flow of materials in the system. Several examples of such applications of ecological principles were given by Caddy and Sharp in Working Paper No. 8. It would also be useful to produce outline charts showing the main fishing grounds, and their relation to spawning areas and nursery grounds. All these would not only help the scientist make assessments sensibly, but could assist in the important task of explaining to administrators and fishermen what is happening to the resource, and why controls may be needed.

There was some discussion of the conditions under which advice based on traditional models could be seriously wrong. General experience, outside tropical inshore waters, is that failures in traditional models are most serious for unstable or erratic stocks. Typical examples are the pelagic species of upwelling zones (e.g., Californian sardine, Peruvian anchovy) whose abundance and catches could vary by two orders of magnitude. The opposite extreme was exemplified by the North Sea plaice, of which the annual catches have (except for periods of war) varied by less than a factor of two during the last century. It was felt that equatorial demersal inshore fisheries probably lay

towards the more stable end of this continuum. This statement needs qualification. Very few long-term studies of tropical fish stocks have been made. In any case the possibility of long-term instability in the stocks can, and should be checked. Except in some of the newer industrial fisheries, the fishermen tend to have a much better basic understanding of the fish than the average fishery biologist. Therefore an early and important stage in any study, and assessment of a fish stock should be discussions with the fishermen, including asking whether they (and their parents and grandparents) have always found the same kinds of fish, or whether they come and go.

To the extent that stability exists, it is more likely to be a stability of the community rather than in any one particular species within that community. In most cases this will not matter. The fishermen may be no more discriminating about species that the ecosystem, and a change in balance between one species and another within a community may provide him with the same amount of food, or the same money from the sale of his catch. This may not always be the case. Off West Africa the change from sardinella (a readily marketed species, if not of very high price) to Balistes (which had no local market) has caused serious problems.

6. Productivity of major habitats

The Working Party reviewed the information on the fishery characteristics of coastal lagoons presented in Working Paper No. 7 by Kapetsky. This document brought together information on the resources and the fisheries of a very large number of coastal bodies of water. The meeting also examined the information on a greater range of habitats compiled by Marten and Polovina (1983). Discussions centred on the extent to which reviews of this kind, looking at the production and yield of fish in similar bodies of water, could be used to estimate the potential yield, or the current state of exploitation, of bodies of water for which very limited data (e.g., on area, or on total catch) were available. This approach had proved very successful for inland waters (lakes, reservoirs, rivers), and the meeting agreed that this approach could be useful, and should be more actively pursued.

In the sea comparisons of the yield per unit area have been applied to coral reefs, starting with the Caribbean studies of J. L. Munro. His method of analysis has also been used for Indian Ocean data, as a simple extension of the production model (Schaefer) technique. Instead of obtaining different parts for the analysis from observation of the same system and different moments of time, observations are used of different systems which are assumed to have the same productivities. In J. L. Munro's original case there were different parishes around Jamaica. These observations may be made at the same time, perhaps as the outcome of a short-term, in depth, programme of data collection, or as a combination of a number of short data series for basically similar areas (Information Paper No. 18). This method should certainly be applied more widely, though it was felt that it might be useful to take some additional characteristics of the fishery grounds (other than area) into account. Possibilities were mean depth and the proportions of the total area covered by coral, sand, and macro-algae.

For coastal areas there may be difficulties because of the variety of habitats - lagoons, estuaries, mangroves, etc. The data presented by Kapetsky showed considerable variation, most of which is undoubtedly due to a lack of homogeneity in the systems being considered. However, it was felt that it would be difficult to make a sharp distinction between, say, lagoon and estuaries. One approach might be to include some important additional features in a multi-variate analysis. This might include:

(i) whether the system is open (e.g., more estuary type), or enclosed (lagoon type)

(ii) the flushing rate

(iii) the depth distribution

(iv) the salinity, whether it is high, low or variable

(v) the oxygen profile

(vi) the effects of pollution or eutrophication - this would almost certainly be non-linear. Many types of pollutants, e.g., domestic sewage, tend to increase production up to some limiting point where the stress is too great, and the system collapses.

(vii) the effects of upland erosion or siltation

(viii) inflow of nutrients from fresh water

A similar multi-variate approach using somewhat different variables can also be used for the fishery productivity of island archipelagoes.

A problem with applying this method is that the number of fishermen and the catch rate interact in two directions. If the natural productivity were indeed constant, then the more fishermen, the lower the catch rate. However, those areas that are naturally more productive would be expected to attract more fishermen. If there is a large pool of potential fishermen, then it is likely that fishermen will continue to enter the fishery until the catch rates fall to an uneconomic level. The data presented by Kapetsky suggested that this was around 1 ton per fisherman per year (a figure which is similar to the limiting level of production observed in some other artisanal fisheries). Depending on which effect is stronger, the observed correlation between number of fishermen per unit area and catch per fisherman could be positive or negative. In particular, the rather weak negative correlation observed by Kapetsky cannot be taken as evidence that the coastal areas are necessarily lightly fished. In fact the clear decrease in catch per fisherman even over the range 0-10 fishermen per km^2 suggests the the effect of fishing is becoming important within that range. This is however no more than a first impression, and the Working Party felt strongly that further analysis along these lines should be carried out.

7. Interactions between fish stocks and other activities

Fisheries in the inshore areas are vulnerable to the effects of other human activities - pollution, land-reclamation, etc. In this they differ from the fisheries in the offshore zones, which support most of the world's large industrial fisheries. These latter are generally only lightly impacted by other activities. A number of examples were mentioned, including destruction of important shrimp nursery areas by land-reclamation, and through clear-cutting of mangroves; loss of coral-reef fisheries through the destruction of the reefs for building or road construction; outbreaks of ciguaterra thought to be triggered off by the killing of corals by siltation; damage by tar-balls and other pollution, which in extreme cases of heavily polluted estuaries leads to losing most of the fishery, etc.

Few of these losses can be immediately quantified - for example it would be difficult to demonstrate that the destruction of x km^2 of mangroves would lead to loss of y tons of shrimp. This difficulty further weakens the bargaining position of the coastal fishermen, which is already weak vis-à-vis most other users of the coastal zone. For example the decision to build a large aluminium plant will not be changed because it will cause the loss of livelihood to some coastal fishermen - though it might be possible to modify the plans of the plant, or the arrangements for waste disposal to minimize the impact.

Similar difficulties of quantification apply to other negative aspects of coastal development. The 'quality of life' cannot easily be expressed in economic terms. Even if the damage is likely to be obvious in the long-run, e.g., the exposure of houses to wave and storm damage following clearance of mangroves, there can be great uncertainty, in advance of the actual clearance, of the extent and probability of such damage. A cost-benefit analysis of any development will contain a lot of assumptions,

and the result can easily come to depend as much as anything on the point of view of whoever makes the analysis. It is therefore important to include an explicit statement of the assumptions made when presenting the results.

The Working Party therefore believed that while it was important to collect more information, and to quantify the impacts on coastal fisheries of other human activities, this was not the only priority. Equally important was to promote a conservation ethic, i.e., a recognition, in the public at large, and in the higher levels of government, of the importance of a responsible attitude to the environment.

The World Conservation Strategy, supported by FAO and other major agencies, has made it clear that conservation is not just a matter for the richer and more developed countries. As the case of coastal fisheries illustrates, the damage done to the environment by poorly-planned developments often fall on the poorer countries, and poorer individuals within these countries.

A powerful instrument for increasing awareness has been the requirement, in an increasing number of countries, for an Environmental Impact Statement in connection with any medium or large-scale development. The dangers associated with such a requirement - that the number of assumptions involved means that answers can be produced to suit any interest, and that preparation of Environmental Impact Statements can become a minor industry, for biologists, economists and lawyers, in its own right - were recognized. Nevertheless, the meeting felt that it was highly desirable that all major developments, e.g., land-reclamation, including those funded by international banks, should include some examination of the impacts of the development on the environment, and in particular, where relevant, on the fisheries. In this connection it was noted that fisheries, and especially the small-scale fisheries, often lack a clear forum, or spokesman, through which their interest can be expressed. This point is taken up elsewhere in the report.

8. Other approaches to assessment

Three levels of sophistication in stock assessment of tropical inshore fisheries were distinguished (Appendix 5). At the highest level it may be hoped that models can be developed that will take into account the special features of these fisheries, and provide very detailed and accurate descriptions of their dynamics. These lie some way in the future. At a more modest level, it has already been pointed out that the traditional methods, though developed for other areas, can usefully be applied. However, even the simplest application of these approaches, and the modifications (e.g., length-structured analyses) to them to make them more immediately applicable to tropical fisheries, still make demands on data that can be heavy in relation to the resources of small developing countries. There is therefore the need for a third level, of simple methods, which can be applied to give preliminary answers with a minimum of data. Several possible approaches were identified.

The first is the examination of the sizes of fish on the market. Many scientists have experienced a sense of shock to see the sizes of fish on the market when moving from the relatively lightly fished areas of parts of the Caribbean or East Africa to the heavily fished areas of Southeast Asia. However, some of these differences may reflect a true zoogeographic difference in species composition, and have nothing to do with fishing. Tempting though it might be to use the overall length composition of the catches (irrespective of species) as an index of intensity of fishing, this would be an over-simplification - though perhaps an over-simplification deserving of further analysis. A more useful approach is to look at the size distribution of the catches of major species. These can be readily converted to the equivalent of a catch curve, from which an index of total mortality can be derived. Comparisons between areas can then indicate where mortality - and hence presumably fishing pressure - is high. This approach can be extended, for example to carry out a length-structured Virtual Population Analysis, but this can no longer be considered a simple method.

Another approach is to look at the overall species composition in the markets. Combining all the catches, irrespective of gear, may avoid the problems of the selectivity of individual gears. Comparisons may be made between areas at the same time, or between different years in the same place. In either case changes may be taken as indications of an effect of fishing. These may not be always easy to distinguish from natural changes in the stock, or from differences in market preference. The latter can, however, be checked by examining the relative prices - if a species is relatively scarce on the market but cheap, then the fishermen are probably avoiding it. If it is scarce, and expensive, then the stock is low, for natural causes or heavy fishing. Distinguishing these latter two possible causes may be aided by noting that there is a progression in the degree to which different species are sensitive to heavy fishing. Skates and rays are easily depleted, while the abundance of many shrimps and cephalopods tends to remain high or even increase even under heavy fishing. An examination of the relative abundance of these "indicator" species in the fish markets can provide a first indication of whether or not the stocks are being heavily fished.

Simple indices may also be used to assess the economic or social health of the fishery itself. Information on the rate of entry into, and exit from, the fishery by both fishermen and vessels can provide a good measure of how successful the fishery is. A short visit to the local shipyards to see the volume of orders for new construction can tell as much, or more, about the recent levels of profit in the industry (and which types of vessels are most profitable) than much collection and analysis of costs and earnings data. Further, the existence of a large back-log of orders for new construction can provide early warning of the problem of over-capacity in the years to come.

In small-scale fisheries talking to the fishermen can provide much insight into the state of the fishery and of the resources. If he makes only a short trip each day - returning by mid-day - and does not use much gear, the resources and the fishery are probably in a good state. Long periods at sea to get enough fish, and the use of large numbers of traps, or gillnets are, conversely, signs, though not infallible signs, of depleted resources, and a fishery in a poor social or economic condition.

Surveys, of one type or another, were mentioned as a potentially useful approach. Surveys can be carried out with several types of vessels - special research vessels, chartered commercial vessels, etc. The typical large research vessel cannot work close inshore and in any case is very expensive to own and operate. Against this was noted that many of the resources exploited by inshore fishermen do occur well off-shore, and that a research vessel possibly chartered for the period of the survey may be able to survey a large proportion of the total resource. Smaller vessels, including chartered commercial fishing vessels, can work closer inshore, though they may have to use a variety of gear. The possibilities of carrying out surveys should always be considered, especially if they can be done without great expense.

9. Fishing methods

Near-shore fisheries are characterized by the great variety of fishing gears that are used - beach seine, lines, traps, lift-nets, etc. The two gears that dominate the industrial fisheries of temperate waters - purse-seines, and trawl - are important, but do not dominate the catches to anything like the same extent. These gears are highly selective in the species and sizes of fish they catch. Each gear takes a variety of species, but no gear takes all species, nor do any species appear in all gears (see, for example, Figure 4 of Caddy (1983). One may reasonably expect that the balance between gears would have an impact on the way the ecosystem is used, and that by intervening to adjust the balance, the management authority could improve the utilization.

This expectation is certainly true to some extent. In particular there are some types of fishery, e.g., dynamiting, that are clearly destructive, and which should be stopped. However, the meeting noted that fishermen are seldom unwilling in principle to stop using these methods. The problem is that often the stocks have been so depleted that only these methods can provide a reasonable catch. The people concerned are seldom in a position to forego today's food in order to eat better next month or next year.

The meeting also emphasized that apart from one or two particularly destructive methods, the problems arose not so much from the nature of the gears used per se, but from the numbers. Put another way, the problem of too many fishermen chasing too few fish will not be solved by adjustments to the types of gear used. On the other hand differences in gear are often correlated with important differences in the social or economic conditions of the groups of fishermen using the various gears. Thus the conflict between trawls and other gears may in part be a reflection of a more general difference in that the trawler owners have better access to capital, credit, and markets and have better managerial and entrepreneurial skills. Here it was noted that with the strong historical trend towards higher real energy costs, there is a corresponding trend, even in developed countries, towards gears that require less fuel than trawlers. The apparent greater economic efficiency, in many countries, of trawlers may not be a correct reflection of current economic conditions, but rather reflect past fuel costs, and greater managerial skills.

Consideration of the conflict between trawlers and other gears, and of the need to promote the use of passive, fuel-efficient gears, lead to a wide-ranging discussion of the possibilities of active intervention on the fishing grounds. This covered the use of Fish Attracting Devices, artificial reefs, and scattering objects on the bottom to obstruct trawls. It was felt that this could be a step on the way to transforming fishing from simply harvesting what nature provides to a more positive activity equivalent to pastoralism or range management on land.

So far as attracting devices were concerned a distinction was made between those that only attracted fish, thus making existing production more easily harvested, and those that actually increased production. The latter type should receive much higher priority, and it was believed that most artificial reefs fell into this class. It was further thought that devices to prevent trawling could, by reducing the damage done to bottom fauna, also increase production. Here a distinction could be made between tropical waters, in which the bottom fauna is on the surface, available to fish, but vulnerable to trawls, and some temperate waters, where much of the fauna (especially molluscs) lie in the bottom deposits, largely invulnerable to trawling, and often also to fish except to the extent that they might be disturbed by trawls.

There was some concern about the cost-effectiveness of different devices. Most studies on artificial reefs had been done in the richer countries, especially those with a large group of well-off sports fishermen. However, it appears that where the material can be obtained cheaply, e.g., old tyres, old ships due for the scrap-yard, etc., and the main costs are those of transport to the fishing grounds, the increase in fish catches (even at conservative market prices) can make the operation economically viable. The meeting believed that more study of the practical, social and economic aspects of the wider use of devices of various types in developing countries would be very worthwhile.

10. Social and economic factors

There is now a wider acceptance that fishery management does not just deal with fish, or with fish and money, but with fish, money and people. This wider prospect is particularly applicable to inshore fishing. The coastal communities which these fisheries support seem particularly exposed to social and economic problems.

To deal with these problems the manager needs widely based sources of information, with good communications with both his technical adviser (biologists, economists, sociologists, etc.) and with the various groups (small-scale fishermen, owners of larger vessels, fish merchants, etc.) whose interests he must consider and so far as possible reconcile. For some groups this latter requirement presents little difficulty. These are usually national associations of trawler owners and of similar groupings with access to the political leadership, and officials of these associations can meet with the government to put forward their views of what needs doing. The small-scale fisherman is not so happily placed. There is seldom any one person, or small group of people who can adequately represent the views of small-scale fishermen, with whom the Director of Fisheries can talk when determining fishery policy. It is not surprising that the interests of small-scale fishermen are ignored, and that whoever benefits from fishery policies, it is the small-scale fishermen and their families who suffer.

The meeting believed strongly that it was necessary to establish better mechanisms by which the interests of the small-scale fishermen could be represented when decisions are taken. This could not be done by imposing a mechanism from the top downwards (i.e., by the national government), nor should it be done in a single stage. Rather it should start at the local level, local groups coming together at the provincial level and so on upwards. This agrees with a growing feeling among many of those concerned with the practical implementation of management that management should start at the community level. That is, in the words of Bailey (1981), there should be 'local control over natural resources exploited by communities of small-scale rural producers.'

Once such a mechanism was in place information could flow in both directions. Scientists need to promote better understanding of what is happening to the stocks and to the fishery, and what regulatory measures are needed. To do this they must use the channels appropriate to the audience. This may mean using the press, radio or television, but often it may be more effective to work through the traditional leaders of the local communities.

11. Advice to managers

In discussing what advice might be offered to managers, the meeting noted that it was not clear who the 'managers' were. It believed that the term should be interpreted fairly widely to include all those whose decisions could affect the manner in which the fishery utilizes the resource. These decision-makers often lay outside the fishery field. Particularly in respect of 'development' policy the fishery specialists may have relatively little influence. Particular mention was made of banks (national, regional and international) and other financial institutions. The interests of these groups are directed towards providing large loans (e.g., for new and better fishing vessels) and the direct repayment of these loans, with little attention to the side-effects of such investment, e.g., on catches of other vessels. Where the natural production is already being fully harvested (as seems to be the case for many tropical inshore fisheries), then increasing the rate at which the harvest is taken will not increase the yield. There is a big difference between fisheries and agriculture - raising the efficiency of the average farmer to that of the best farmer would greatly increase food production. Doing the same in fisheries would in many cases not increase the total catch significantly and might decrease it.

This is not to say that all investments in fisheries is counter-productive. Better shore facilities, and improved handling and marketing can increase the value to the consumer, and to the fisherman, without immediately increasing the pressure on the resource. Such investments, and other actions to improve the quality of life and working conditions of the fisherman, must be encouraged. However, the indirect long-run effect of shore-side investment may well be to attract more catching capacity into the fishery and thus add to management problems. There are also some resources that can still supply higher catches. However, the meeting believed that there was a strong need for a change in emphasis in the attitude to investment in fisheries, towards caution, and towards putting the burden of proof on those who believe that,

for a given resource, more fishing will mean more catch. This change in attitude is apparent at the higher levels of some institutions, but needs to be more widely spread, particularly among the officials whose interests lie in placing more loans without too much attention to the long-term effects. All loans for fisheries that involve increasing capacity should be preceded by a careful analysis of the effects on the stock, and on other fisheries, and should be conditional on the establishment or maintenance of an adequate institutional framework for the long-term management of the fishery. This could include an element of training for local fishery officers.

So far as management, in the more restricted sense of applying regulations and controls, is concerned the meeting could add little to what had already been discussed under item 4 of its agenda. There is a wide array of management tools, each with its advantages and disadvantages. The choice of tool must be matched to the local conditions. Most of the tools (with the probable exception of catch quotas) may find applications in tropical inshore fisheries, but in these fisheries it is even more desirable than elsewhere to take preventive action before fishing has reached a critical level, rather than delay action.

This means that scientists must keep the managers and fishermen properly informed about their knowledge of the status of the stock, even when the information is far from comprehensive. In this way the managers can be prepared early for taking action. The form in which the information is presented must be easy to understand and use. The format used in Morocco (Information Paper No. 20) was mentioned as a suitable example.

The meeting discussed whether the conclusions of the scientists should be presented to the decision-maker as recommendations or as options. On the one hand it was felt that the scientist should not try to assume the manager's responsibilities. On the other it was recognized that other interests will usually put direct pressure in favour of some preferred action, which would tend to outweigh a neutral even-handed statement. It was felt that the proper approach was to present options, but in doing so to spell out quite clearly the effects of different alternatives, especially the indirect effects which might otherwise not be properly appreciated.

12. Data needs

The data available for the biological, economic and social study of tropical inshore fisheries are usually poor or very poor. Without adequate data, it is difficult to give good advice on managing these fisheries. The improvement of data therefore should have high priority. However, because the fisheries are scattered, collection of data is difficult and likely to be considerably more expensive than collecting equivalent data from an industrial fleet landing the same amount of fish. At the same time the resources (trained people, cash, etc.) available for data collection are limited.

The meeting therefore believed that it was more important to identify which items of data were of prime importance, and how data could be collected in a cost-effective manner, than to make a comprehensive listing of all the data that would be desirable to have, if that were possible.

Few data need to be collected in a comprehensive census type manner. For example it is unnecessary, as well as impracticable, to have records of the landings by all boats at all landing places on every day. A well-designed sampling system will produce data that is sufficiently accurate (low enough variance) for all purposes, and which should be less subject to the errors and biases involved in attempting a complete census. Further, it is not necessary to have all data every year. For example, the sample survey should be based on a complete census (frame-survey) of the fishing villages and landing places. This need be done only perhaps every 5 or 10 years, depending on how rapidly the fisheries are changing.

New approaches to data collection can often by very useful. For example flights by a light aircraft along the coast (particularly when it is not deeply indented) can often provide more information on what types of vessels are working, and how many, more quickly, more accurately and more cheaply than visits by land. So far as possible data collection for different purposes (biological, economic, etc.) should be integrated - and in fact much of the basic data is needed by several users. Thus those collecting landing data during catch assessment surveys can also collect other data, either by observing changes in the fishing village (e.g., construction of a fish-drying shed), or by asking fishermen about their practices in sharing the proceeds of the catch. Widening the responsibilities of the collector in this way could increase their interest in the work , and thus improve the quality of the basic records. Mention was also made of the value of local village records of different types as sources of important socio-economic data.

Catch data is essential. This should usually be collected by sampling. Catches are usually considered as equivalent to landings, but in some fisheries significant quantities are discarded (though this is less important in most inshore fisheries than in some offshore industrial fisheries). Where discards may be important, data should be collected, but this would probably be best done by occasional special enquirers.

Species data, at some level, is also essential. However, too many species are landed to include information on all species in all records. The basic records, e.g., from catch assessment surveys, should therefore be in terms of well-defined (by species) and well-recognized (by the fishermen and statisticians) groups - perhaps 20-30 in number. Special observations should then be made of the precise species composition within each group, with attention being given to the presence of pre-determined target or indicator species . Because of seasonal variations these surveys should continue over a 12 month period, but could be carried out at intervals of more than one year. Species data should be tied to the type of gear used. This implies data should be collected at the point of landing, not in the market place.

Effort data - numbers of boats, number of landings, etc. - are also needed by most users, although problems of effort calibration in a multi-gear fishery are not negligible. Collection of effort data should be matched with records of the catch taken by that effort - otherwise later interpretation is difficult or meaningless - and data from different types of vessel or gear should be kept separate. Interpretation of effort and catch-per-unit effort data by biologists and economists will be different. Biologists will want to look at data for a given stock, ignoring occasions when a given vessel will be fishing different stocks; economists will generally want to look at the returns to a given vessel, regardless of what stocks are fished. Compilation of effort and c.p.u.e. data will need to take these differences in interests into account.

The range of biological data that is of possible interest is immense. Mention was made at various points in the discussion of the value of studying feeding habits, migrations, growth, maturation, etc. These, however, should be carried out when resources are available, or when it is clear that the information is directly applicable to some specific practical problem. Most of these data can be collected when needed, and the existence of a series of data over a period of years is not necessary.

The one item of biological data for which high priority should be given is length. With the new techniques being developed length data can be used to provide an early index of the health of the stock, more detailed assessments, and measures of many of the other biological parameters (growth, mortality, etc.). The meeting believed that the properly planned collection (and analysis) of length data should receive high priority.

Collection of data on all species would probably be impossible, and work should be concentrated on certain indicator species, chosen to cover the main groups - those that might be relatively insensitive to fishing as well as those whose size-composition would be expected to provide early measure of any effect of fishing. Because of gear-selectivity the gear used must be known, though it may not be essential to sample all

gears. Again it is essential to sample throughout the year, though if the fishery is not changing much it may only be necessary to repeat the sampling programme at intervals of some years.

The data needs for economic studies were discussed on the basis of the paper by Willman (Working Paper No. 6). It was noted that the table appended to that paper provided a useful listing of the data that were desirable for good economic studies, several of which are important for monitoring the health of the fishery. Some of the data listed - number of landing places or fishing communities - were essential for setting up sampling surveys. Others - e.g., volume of landings - have been discussed earlier.

The priorities that should be given to the other items listed would depend on how the economic analyses were used, and the importance of the results to practical decisions, particularly when considerations of equity and resolutions of conflict are important in taking fishery management decisions. It was felt that data on income distribution were likely to be among the more important items. The ultimate use of the results was also important in deciding how the data are handled. For example, an important aspect of cost and earnings study lies in the comparisons between different gears in the same year, and between years for the same gear. Another use of the same data, important in determining policy towards expansion or control of fishing effort, lies in the breakdown of costs into fixed costs (regardless of whether a vessel fishes or not), running costs (related to fishing effort, in the biological sense), and costs determined by the volume of the catch (ice, landing fees, etc.). This breakdown is necessary to transform biological models into bio-economic models.

In conclusion the meeting felt that the priorities in biological, economic or sociological data collection could not be set by biologists, or economists or sociologists in isolation. They should be set as a result of a multi-disciplinary problem. In this connection the data sets collected by the University of Philippines/ICLARM team studying San Miguel Bay presented in tables by Pauly and Smith (Working Paper No. 5) were felt to be a very useful example of the type of data needed in an in-depth multi-disciplinary study. This table also illustrates the frequency of sampling that was felt to be necessary during an in-depth study.

13. Future research

The general requirements for fishery research, particularly in the biological fields, have been well spelt out in numerous publications, including FAO manuals and Technical Papers. The meeting did not feel that it would be worthwhile producing yet one more shopping list of useful research activities. The priority within the biological field is to carry out stock assessment studies along the well-established lines. In due course, when these lines prove unable to provide adequate advice, they will need modification to take account of the special conditions of tropical inshore fisheries in general, or ultimately of the particular fishery being examined. However, with limited resources it is important to have a plan of how the research is to be executed, and which particular activities should receive first attention. A chart was produced (Appendix 5) which illustrates the multi-disciplinary structure of fishery research. Elements high in the chart should generally receive attention before proceeding to items lower down.

Inshore fisheries present a variety of problems, and managers need advice from several disciplines in order to solve them. The meeting felt strongly that this multi-disciplinary advice should so far as possible come from multi-disciplinary research rather than from the stapling together of reports of a number of single-discipline studies. The work of the University of Philippines/ICLARM team, in which biologists, economists and sociologists together studied the fisheries of San Miguel Bay, was pointed out as an example of the type of study that should be done more frequently. Though this clearly cannot be done for all a country's fisheries, an in-depth study of one or two examples can give insight that can be applied throughout the country. If possible such studies should also involve the management authorities.

A perennial problem is the lack of suitable research scientists. Universities tend to turn out biologists (or possibly marine biologists and fish biologists) but not fishery biologists; economists or sociologists but not fishery specialists. That is, the graduates from universities do not understand how to apply their learning of the basic sciences to the problems of fisheries. Despite the continuing efforts of FAO and other institutions, there is a need for more training in the basic techniques of fishery research (simple stock assessment, etc.). This training should include training in making sure that the results of research can be used - how reports on research should be presented to managers and others so that they can be understood. Most fishery scientists also need training in how to use the literature. Far too much time is wasted by failing to use well-established techniques, or in developing a technique that has already been developed elsewhere. Mention was made of the ICLARM Network of Tropical Fishery Scientists as one mechanism of making scientists particularly in developing countries better aware of the relevant literature.

The meeting noted that the zone from high tide out to 10 m depth, which supports much of the inshore fishery has been very poorly studied, particularly in a quantitative, rather than a descriptive manner, despite being a productive area for many high commercial value species in the tropics. Fishery research has often been concentrated on the depths beyond 10 m, which are accessible to properly equipped research vessels. University studies, which are in any case mainly descriptive, tend to be limited to the inter-tidal zone. Between is an area for which more quantitative research - in addition to the directly mission-oriented fishery research - would be very useful. It was also felt that the comparative approach recommended by Regier (1982) for tropical inland waters had considerable potential for near-shore marine waters also.

Apart from these general observations, the meeting also identified some more specific research topics which deserved attention. These included:

(a) Compilation of long-term data on major environmental factors likely to be relevant to inshore fisheries, e.g., wind, run-off of major rivers, extent of mangroves and wetlands (which can often be obtained fairly readily from satellite data).

(b) economic studies of the interaction between the fisheries and other sectors of the economy.

(c) introduction and multi-disciplinary study of management measures in selected small areas.

(d) studies on different gears, especially passive types, and those requiring little energy.

14. Adoption of the report

The report was adopted on 4 March 1983.

15. Future activities of the Working Party

The Working Party believed that during its session it had been able to make a good overview, at the global level, of the problems of managing tropical inshore fisheries. It had succeeded at pointing up the main lines of work, and had thus fulfilled its principal terms of reference (see Appendix 4). The main need was to pursue the work, particularly at the national level. It therefore believed that there was no need for a further session to examine global issues in the immediate future, but FAO could usefully consider meetings, perhaps as part of the activities of its regional bodies, to follow up the work at the regional level.

16. References

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Regier, H.A., 1982 Training course on the management of small-scale fisheries in the inland waters of Africa: conceptual framework and approaches for the acquisition of key resource information. FAO Fish.Circ., (752):25 p.

APPENDIX 1

Agenda and Time-table

Monday, 28 February

1. Opening of session; adoption of agenda and arrangements for the meeting
2. Review of terms of reference, and related meeting
3. Identification of management problems
4. Approaches to management

Tuesday, 1 March

5. Use of traditional stock assessment methods
6. Productivity of major habitats

Wednesday, 2 March

7. Interaction between fish stocks and other activities
8. Other approaches to management
9. Evaluation of fishing methods
10. Social and economic factors

Thursday, 3 March

10. Social and economic factors (continued)
11. Advice to managers
12. Data needs and data collection

Friday, 4 March

13. Future research
14. Adoption of report
15. Consideration of further activities of the Working Party

APPENDIX 2

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APPENDIX 3

List of Documents

WORKING PAPERS

1. Draft Annotated Agenda
2. Draft Time-table
3. Case Study: Brazil, by S. JABLONSKI
4. Case Study: Nigeria, by T. O. AJAYI
5. Case Study: Philippines, ICLARM
6. Economic information needs for small-scale fishery management, by R. WILLMANN
7. Some characteristics of coastal lagoon and estuarine fisheries, by J. KAPETSKY
8. Some useful ecological concepts in fishery assessment, by J. CADDY and G. SHARP

INFORMATION PAPERS

1. List of documents
2. List of participants
3. Stock assessment for tropical small-scale fisheries. Report of Workshop at the University of Rhode Island, September 1979
4. Extracts from the report of the ICLARM/ADAP Workshop on Multi-species Fisheries, January 1981
5. Some considerations for the management of coastal lagoon and estuarine fisheries, by J. KAPETSKY. FAO Fish.Tech.Pap.No. 218
6. Problems of applying traditional stock assessment techniques and suggestions for improvement. Extract from Report of 3rd Session of IPFC/SCORRAD
7. Traditional use of reef and lagoon resources, by R. E. JOHANNES
8. Draft report of the Workshop on Territorial Use Rights in Fisheries, Rome, December 1982
9. Report of the Ad Hoc Working Group on Artisanal Fisheries. Cotonou, July 1980. CECAF/TECH/80/28
10. Report of the Consultation on Artisanal Fisheries in the CECAF Region. CECAF/TECH/82/39
11. Recensements de la pêche artisanale maritime au Senegal. Avril et Septembre 1981. CRODT, Doc.Sci. 83, Mai 1982
12. Les enquetes socio-economiques au centre de recherches oceanographiques de Dakar-Thiaroue. CRODT. Archive 110, Mai 1982
13. Report of the First Technical Consultation on Stock Assessment in the Central Mediterranean. GFCM. FAO Fisheries Report No. 266.
14. Draft Report of the Expert Consultation on the Regulation of Fishing Effort (Fishing Mortality) - Part I and II
15. Fishery Committee for the Eastern Central Atlantic: Distribution, migration and spawning of the main fish resources in the northern CECAF area. CECAF/ECAF Series 82/25
16. Assessment of the Shrimp Stocks of the West Coast of the Gulf between Iran and the Arabian Peninsula. FI:DP/RAB/80/015
17. Production modeling using mortality estimates, by J. Csirke and J. F. Caddy. (Reprint: Can. Journal of Fisheries)
18. Production modelling without long data series, by J. F. Caddy and S. Garcia
19. Mapping of Shelf Areas for Fisheries Yield Estimation, by J.F. Caddy and D. Piaggesi
20. Periodes et zones de reproduction des principales espèces halieutiques dans les eaux marocaines et possibilités éventuelles d'amenagement, Note d'information No. 1, ISPM, Maroc.

APPENDIX 4

Advisory Committee of Experts on Marine Resources Research (ACMRR)

Working Party on the Management of Living Resources in Near-Shore Tropical Waters

TERMS OF REFERENCE

(as set forth at the Tenth Session of the ACMRR, November 1981)

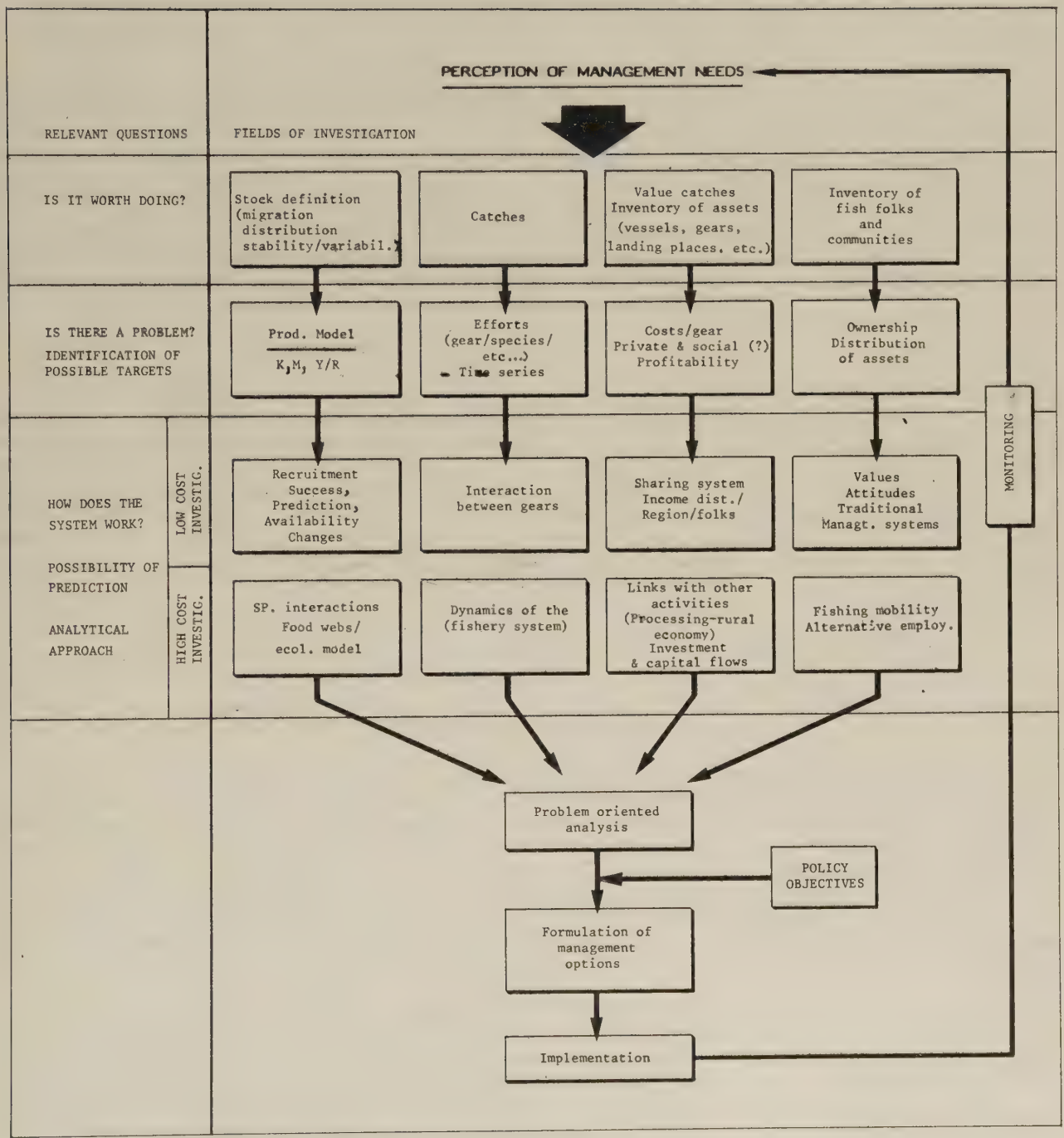
(i) To determine the appropriate information needed and the methodology required in assessing multispecies fisheries in the near-shore waters.

(ii) To evaluate the basic physical, biological, economic and social factors for the rational utilization of living resources in the near-shore waters.

(iii) To suggest appropriate mechanisms for implementation of management of near-shore living resources, particularly for small-scale fisheries development.

(iv) To submit a report on the above activities and recommend further action to ACMRR.

APPENDIX 5


PERCEPTION OF MANAGEMENT NEEDS
RELEVANT QUESTIONS
FIELDS OF INVESTIGATION
IS IT WORTH DOING?
Stock definition (migration distribution stability/variabil.)
Catches
Value catches Inventory of assets (vessels, gears, landing places. etc.)
Inventory of fish folks and communities
IS THERE A PROBLEM? IDENTIFICATION OF POSSIBLE TARGETS
Prod. Model
K,M, Y/R
Efforts (gear/species/ etc...) - Time series
Costs/gear Private & social (?) Profitability
Ownership Distribution of assets
HOW DOES THE SYSTEM WORK?
POSSIBILITY OF PREDICTION
ANALYTICAL APPROACH
LOW COST INVESTIG.
HIGH COST INVESTIG.
Recruitment Success, Prediction, Availability Changes
Interaction between gears
Sharing system Income dist./ Region/folks
Values Attitudes Traditional Managt. systems
SP. interactions Food webs/ ecol. model
Dynamics of the (fishery system)
Links with other activities (Processing-rural economy) Investment & capital flows
Fishing mobility Alternative employ.
MONITORING
Problem oriented analysis
POLICY OBJECTIVES
Formulation of management options
Implementation

ECONOMIC INFORMATION NEEDS FOR SMALL-SCALE FISHERIES MANAGEMENT

by

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1. INTRODUCTION

This paper focusses on the economic information desired for fisheries management with special reference to the small-scale fisheries sector. It starts off with a brief discussion on defining the borders or overlap of management and development measures in fisheries and the consequences for the scope and extent of information requirements. It then tries to systemize the information needs by broadly dividing management into three interconnected functions, namely: monitoring, intervention and evaluation. For each of these functions, the information requirements are discussed in terms of scope, specifically continuity and method of acquisition. Appendix 1 lists the types of information that might be collected, noting the main use (Monitoring, intervention or evaluation) to which they could put and the sources and methods of collection.

2. DEFINING FISHERIES MANAGEMENT

One of the difficulties in determining the economic information needs in fisheries management lies in deciding on the measures or interventions subsumed under this term and in demarcating them from development activities. In some of the recent literature, management has tended to be considered in increasingly broader terms, incorporating social institutional and economic development. This "extended" concept of management takes explicitly into account that the problems of small-scale fisheries management cannot be seen in isolation from the developments in the surrounding coastal and rural economy. It also reflects the greater awareness of the multitude of political, cultural, social and economic aspects which affect the mobility of productive factors in and out of fisheries. Many social and cultural factors which enhance or are impediments to the development of a fishery can possibly also be conceived as interventionist instruments to manage a fishery. For example, the provision of better educational facilities may increase the labour mobility out of fisheries; family planning measures may reduce the natural population growth in the fisherman population, or the abolishment of cultural barriers, e.g., caste system, may increase the labour mobility into fisheries.

This widening of the concept of fisheries management over time can also be observed in the change of its stated objectives: from maximum sustainable yield via maximum economic yield to the present optimum social yield. This shift from "fish" to "fish and money" and finally to "fish, money and people", while it shows greater appreciation of the complexity of the subject, led at the same time to a reduction in the specific content of the objectives. The scientific basis in establishing management objectives has been overlaid by social considerations, which are frequently not quantifiable, have to be country- or area-specific and undergo continuous change in course of political and economic developments.

In the context of tropical multi-species fisheries in developing countries, even the definition of the maximum sustainable yield is an ambitious task owing to the complex interdependencies between various fish stocks and considerable yearly fluctuations in their relative and absolute abundance. Under these conditions, the desire of economists to be able to manage for maximization of the economic rent appears a fruitless aim. If the total sustainable yield and its composition change from year to year and if the prices of different fish species are demand-elastic, rent maximization does not only imply that optimal fishing effort and optimal mix of fishing methods will have to change from year to year, but it also requires that the demand elasticities of the prices of different fish species will have to be known to adjust fishing methods and fishing effort accordingly. A long-term economic rent maximization seems to be an even more obscure aim of fisheries management, because this would require a full knowledge of the interdependencies between different fish stocks and how the potential of one fish species is influenced by the exploitation of one or several other species.

Given the difficulties in either determining maximum sustainable yield or achieving maximization of economic rent, fisheries management can at best be concerned with attaining second or third or ....nth best solutions. These solutions will be more related to the avoidance of severe ecological, economic and social disturbances like, for example:

- avoidance of severe decline in landings or of stock depletion,
- avoidance of severe overcapitalization,
- reduction of conflicts between competing sections of fishermen,
- securing a minimum level of income and quality of life for the fisherfolk,
- avoidance of regional imbalances in income, employment, fish supply, etc.

A first set of information is thus required for monitoring a fishery, which provides early indication of likely disturbances to the ecological, social, economic and regional balance of the fishery. Economic and social imbalances may be measured in increasing regional and personal income disparities, in absolutely declining incomes, in rising costs of fishing at constant level of catch, in increasing unemployment, in reduced supply of fish to rural areas, in increased conflicts, etc. This monitoring function of fisheries management is essential for timely interventions, then as Gulland and Robinson (1973, p. 2047) have put it: "It is much easier to persuade people not to do something they are at present only contemplating than to stop them doing something in which they are already engaged."

The second function of fisheries management, the intervention can have various features. Most measures undertaken in the name of developing a fishery will have management implications, as they affect fishing effort, income levels and distribution, employment, geographic and social mobility, etc. In an underexploited fishery, management will be more concerned with controlling the speed and direction of the development process and with distribution considerations, while in an exploited fishery the limiting function of management - which has also distributional implications becomes more prominent. Economic information is required to decide on the right types of interventions to accelerate or slow down the expansion of fishing capacities, to limit or reduce fishing effort and to solve distributional problems.

The third function of fisheries management, the evaluation, is closely linked to the monitoring function. It basically tries to monitor the efficiency of the selected set of interventions in achieving their pre-described objectives. Efficiency will hereby be measured in relating the costs of the interventions - including costs of enforcement and information - to the expected or attained benefits. In many cases, it will not be easy to measure the benefits of one or a set of interventions. On one hand there may be a considerable time-lag between the introduction of an intervention and the occurrence of benefits. On the other, benefits and costs will not only arise in the form of quantifiable figures, but also in qualitative changes.

3. MONITORING

Presently, a continuing monitoring in fisheries - if it exists at all - refers usually only to biological information, viz., specieswise catch statistics, and to a few technical data on fishing craft and gear.

The few economic surveys undertaken in small-scale fisheries in the past have been one-time efforts, which have either covered a whole range of social and economic information, starting from demographic and educational data and ending with information on the fish marketing system, or they were very specific, concentrating on one or two aspects of the fisheries sector, such as the functioning and effects of the credit system.

Made in advance of, or during specific development projects or programmes, these surveys have been very valuable. For purposes of fisheries management these types of studies have two basic disadvantages:

(i) they provide only a static snapshot picture of the prevaling conditions and thus do not allow an analysis of trends;

(ii) they are usually limited in regional coverage to the project area.

For the decision-making process in fisheries management, a continuing up-to-date flow of a selected number of basic economic data is, however, essential for capturing the dynamic nature of fishing activities and for timely interventions.

For monitoring most fisheries situations the collection of economic information which will detect changes in the following areas is important:

- investment,
- income and profitability,
- regional and personal income distribution,
- employment.

Economic information should preferably be acquired for the entire fishery sector, including forward sectors like fish marketing and fish processing, as well as backward sectors like net-making, boat-building, etc. Developments in forward sectors will influence the output value of fishing, while those in backward sectors will have an impact on the input costs of fishing. Backward and forward sectors offer also considerable employment opportunities especially for women.

Under imperfect market conditions - which are more often the rule than the exception - a part of the economic rent attached to the resource may be appropriated in these forward and backward sectors through underpriced outputs or overpriced inputs. In unregulated fisheries, imperfect market mechanisms can have effects comparable to a tax and may be the only source of an economic rent in fishing, though with no direct benefits to the fishermen. In practice it will be difficult to determine the "correct" equilibrium price of outputs and inputs and thus to measure the economic rents acquired in these sectors. However, to avoid the implementation of wrong management measures, it is important to get an idea of which direction imperfect market conditions work. Do they improve private profitability at the cost of social benefits (subsidized inputs, price supports etc.) or vice-versa (high interest rates, church or village taxes, etc.)

Keeping in mind the limited financial resources available for continuing information systems, a first priority for countries with indications of immediate or likely future management needs - either because of increasing conflicts between competing groups of fishermen, large income disparities or because of overcapacities - will be the collection of economic data on the actual fishing operations.

It will usually be necessary, in relation to specific management decisions to supplement this information by surveys focussing on some additional specific subjects, depending on the actual situation in the country. These might include marketing, processing, or alternative employment potential in coastal areas etc., and socio-political and socio-cultural information.

3.1 Investment

A fairly good indicator of the level of investment - or fishing capacity - in fisheries is provided by records of the number and types of fishing craft and gear, preferably further broken down into artisanal and industrial fleet and by region, harbour, or village. Figures of the yearly catch per craft or gear can give in many instances some idea on the "health" of a fishery. There are, however, two drawbacks:

- the catching capacity of the craft or gear may increase owing to technical improvements (motorization, larger vessel, power block, etc., nylon twine, thinner twine, larger nets, etc.)

- the intensity of utilization may change over time (diversification of fishing methods, more working hours, etc.)

Both changes may increase fishing effort or costs of fishing without showing an increment in the number of fishing implements. Technical improvements in craft and gear, which increase the catching capacity, are usually - though not always - connected with

higher investment costs, while changes in the intensity of utilization will affect the operating costs.

If the recording of the numbers of craft and gear includes also details such as length, tonnage, horse power, power block, nylon or cotton twine, etc., variations in the catching capacity would also be shown.

A recording of the actual investment costs of the total fleet makes little sense in most small-scale fisheries situtations. On one hand the collection procedure would be extremely costly, on the other - and more important - one couldn't really deduce from the figures why there has been a rise or a decline in the total investment. A change can be the result of:

- more or less fishing implements,
- technical change,
- inflation/deflation,
- real price changes arising from supply and demand alterations.

The assessment of the number and types of fishing craft and gear in the small-scale sector is usually undertaken in frame suveys, which are conducted in a periodicity of 3 to 5 years. Larger vessels of the industrial fleet have frequently to be registered with the authorities, so that up-to-date figures are readily available. It would be preferable to get yearly information on fishing implements also for the small-scale sector. One possibility could be to keep records on village level; a proposition which appears feasible in many developing countries. Such records could then also include information on ownership distribution, which is an important indicator for the economic power structure in an a community and which affects income distribution.

3.2 Income and Profitability

In the past only a few economic suveys have been undertaken in small-scale fisheries, which show the profitability, the incomes and the costs of fishing. This is not really surprising when considering the costs of such suveys. A first question to ask is therefore: Do we need such information? There are several reasons which can be mentioned to support a "yes":

- income is an important indicator for the living standard of the fisherfolk; income differentials between fishing and other activities may lead labour force to enter or to leave fishing;
- profitability can be an important indicator of the "health" of a fishery; diffirentials in profit rates between fishing and other sectors of the economy will lead to entry or exit of capital;
- differences in profit rates between different kinds of fishing may also indicate potentials for conflict;
- measures like taxes, subsidies, credit schemes, price support, etc., should be justified on the basis of information on present and potential incomes and profitabilities;
- decisions on the introduction of new technologies (where, what fishing methods, etc.) should be based on this information;
- the efficiency of small-scale fishing methods as compared to large-scale fishing can usually not be appreciated without hard facts and economic analysis.

If we agree on the usefulness of such information, the second question to ask is: How do we acquire the information and how much does it cost? Four approaches are conceivable, which in the order of listing combine increasing costs of acquisition with increasing informative content:

(i) socio-economic indicators or surrogates for detailed studies such as changes in shares paid to labour, changes in lease fees for vessels (Christy, 1981) or changes in average age of fishermen, etc.;

(ii) secondary sources of information such as population census, company records, statistics from other sectors (trade, agriculture, health, consumer expenditure survey, etc.);

(iii) integration of some economic inquiries on fish prices, input costs etc., in the catch assessment suveys;

(iv) special costs and earnings sample surveys.

The first two approaches may provide a rough picture on the socio-economic conditions in small-scale fisheries. Presumably, such information will be of limited analytical value, because it doesn't show the reasons for changes, trends, etc. The fourth approach may be too costly to be undertaken on a continuing basis. With the third approach we may arrive at reasonable estimates of average incomes (from fishing) per fisherman and average profitability by major fishing methods, possibly further broken down by geographic area. For purposes of fisheries management such information may already suffice, particularly when supplemented by information from secondary sources.

The possibility of integrating some economic data in the catch assessment surveys needs particular attention. Basically, this implies that in addition to recording the quantities caught, data are collected on the shore value at first sale, preferably also on the prices of major species, on owner and common operating costs and on the sharing system. The investment costs could be roughly estimated on the basis of the current price of new craft and gear and the assumed average lifetime.

3.3 Employment

In many coastal areas of developing countries, the fisheries sector - harvesting, marketing, processing, supply industries - provides the major part of employment opportunities. Frequently, the structure of the harvesting sector - in terms of geographic distribution, mode of operation and capital intensity - is the determining factor for the structure of backward and forward industries.

A change from highly dispersed, labour-intensive small-scale operations to industrial fisheries usually implies that a similar shift takes place in backward and forward industries, with the consequent effects on regional employment and income distribution.

The prime indicator of the level of employment in fishing is the number of full-time and part-time fishermen. A first source for getting estimates on the number of fishermen are population census figures. In coastal villages it can be assumed that a high percentage of the grown-up male population is engaged in fishing or fishery-related activities.

Obviously such figures will not be very reliable, as the periodicity of population cencus is 10 or more years, and we do not really know the labour participation rate and cannot distinguish between full-time and part-time fishermen.

It is thus preferable to either conduct special suveys in a periodicity of 3 to 5 years or to keep records on village level.

But even when knowing the actual number of active fishermen, we do not know the real level of employment in terms of man-days, or man-hours spent at sea. This information could again be collected in course of the catch assessment survey. In multi-species artisanal fisheries the catch per man-hour of fishing or per man-hour at sea may be a suitable surrogate indicator for catch per unit of effort.

4. INTERVENTION

Intervention is here defined as one or a set of masures undertaken by the government, which aims at altering basic parameters of the fisheries sector. Basic parameters can refer

to social, cultural, political, economic, technical and institutional aspects. Such a broad definition leaves room to incorporate development measures as well as management measures in a narrow sense of limiting or reducing fishing effort.

Before an intervention is undertaken, two questions have to be answered:

(i) what are the objectives of the intervention?

(ii) what types of measures should be implemented?

The most common objectives of fisheries development are (1) to increase output; (2) to raise the standard of living; (3) to increase export earnings and(4) to maintain or increase employment (Smith 1979, p.7).

Where the fish resources supporting the fishery are being fully exploited, these objectives cannot all be pursued simultaneously. Attempts to raise the standard of living of the individual fishermen, e.g., by introducing improved technology, can only be successful if the total employment is reduced in proportion to the improvement in individual productivity. This raises the serious question of the manager's proper attitude to technological improvement under conditions of heavy exploitation.

Before discussing the potential interventions, we should recollect the reasons which have led to a situation where nearshore resources are exploited at a high level. The prime reasons were:

- technological progress combined with an influx of capital,
- natural growth of the fishing population,
- entry of labour force from other sectors of the economy.

Technological progress has three effects:

(i) it increases the productivity,

(ii) it may lead to the exploitation of hitherto unaccessible resources,

(iii) it affects the levels of income and employment and their distribution.

The effects on the level of income and employment depend on the relationship between increase in capital and labour productivity and increase in sustained catches. Unless the resource is lightly exported is less than proportional to increase in labour productivity, and will be zero or negative in very heavily fished stocks. Thus improved technology can result in increasing unemployment, declining income and labour productivity for one section of the fisherfolk in favour of higher income and productivity for those in possession of the new technology.

Even when industrial fisheries do not negatively affect incomes and labour productivity in existing artisanal fisheries, they can restrict the possibilities of further expansion. This may have severe consequences for the future, considering the high population growth and the lack of alternative employment opportunities elsewhere.

Two management questions arise from this:

(i) should the introduction of labour-saving technologies be prevented?

(ii) should a part of the resources which are presently exploited by industrial vessels be reallocated for exclusive use by small-scale fishermen - and if "yes", how can this be done?

The main argument against the prevention of labour-saving technologies is commonly based on efficiency considerations. Unfortunately, such statements are hardly ever supported by facts, or are based on a misunderstanding of the term "efficiency" as meaning private profitability. In labour-surplus economies the opportunity costs of labour are close to zero. Thus, from a societal point of view, there is no benefit in freeing labour force bound up in fisheries for non-existent productive activities in other sectors of the economy.

The capitalization process in the fisheries sector of industrialised countries was closely linked to increasing opportunity costs of labour, which were the result of a rising labour demand in other sectors of the economy, primarily in industry.

It should be emphasized that the prevention of labour-saving technologies is not justified in those cases where resources further offshore still offer higher catches, and where the technologies cannot be used in already fully-utilized fisheries. Frequently, off-shore resources can only be economically exploited through capital-intensive technologies. But even here, intermediate technologies are conceivable (e.g., beach-landing craft, mother boat operations), which keep the labour-intensity at a comparatively high level.

Information needs with regard to the choice of technology are:

- opportunity costs of labour and level of unemployment or underemployment in coastal regions;
- accessibility of unexploited resources through new, intermediate technologies;
- comparison of the "social" efficiency of alternative choices of technology;
- the impact of laternative methods of influencing the choice of technology (import restrictions, tax on capital inputs, fuel etc.);

Reallocation or allocation of inshore resources for the exclusive use of small-scale fishermen has been tried out in the past by several developing countries. Laws have been established which prohibit industrial vessels over a certain tonnage from entering inshore fishing areas in a specified distance from the shore. These regulations are by and large not very successful. For these failures several reasons can be mentioned:

- highly-priced species, mainly shrimps, have their habitat in nearshore fishing areas;
- over-capitalization of industrial fleets combined with rapidly rising fuel prices supressed profit rates in offshore fishing with a consequent redirection of fishing effort to near-shore resources;
- lack of political will to effectively enforce the laws;
- high costs of enforcement

The most important consideration here is, however, the lack of limitations on the numbers, catching capacity and fishing methods of the industrial vessels. If the exploitation of offshore resources remains at a high level of profitability, there is little incentive to intrude into inshore resources. Similarly, if inshore trawl fisheries remain highly profitable there is no need to diversify the fishing methods from shrimp fishing to those fish resources which are either already the mainstay of artisanal fishermen or could be exploited by them after disseminating the appropriate technology. A management strategy should therefore be considered which limits the fishing efforts of the industrial fleet, possibly combined with price supports for offshore fish species, to balance the profitability of inshore and offshore fishing. Again, the basic information requirements refer to data on costs and earnings of the various fishing methods.

Even when it is assumed, perhaps optimistically, that conflicts between idunstrial and small-scale fisheries can be eliminated, the question style remains how to avoid over-fishing and overcapitalization of the inshore small-scale fleet itself. As Smith (1979, p.27) has put it: "Once a traditional fishery is overexploited, the only solution with any long-range outlook is one that reduces fishing effort, either through limitations on entry or harvesting power or through sufficient incentives in alternate activities. Given the thought (and costs) of trying to manage 35 million traditional fishermen, planners could be excused if they opted for the latter!" Let us at first consider the option of alternative activities. The creation of alternative employment in rural areas is a general development aim of many highly-populated developing countries. The number of fishermen in relation to landless agricultural labourers is frequently rather small. Assuming free

entry of labourers into traditional fisheries, the option of alternative activities means nothing less than reducing unemployment and underemployment in rural ares and increasing the opportunity costs of labour (wages). An increase in the opportunity costs of labour (at constant cost of capital) would, however, be an incentive to sustitute labour by capital inputs. The consequent higher labour productivity may compensate or even surmount the reduction in fishing effort achieved through the exit of a part of the fishermen into alternative employment. Obviously, as the development in industrialized countries has proven, the fact of employment options outside of fisheries does not prevent overcapitalization and overfishihg.

From the above it follows that, though the creation of alternative employment is a necessary condition to increase the incomes, it does not suffice to manage a fishery, as the entry of capital is still open.

Limiting the entry of capital - and if desirable also of labour - can either be done through:

- administrative means,
- self-control by the fisherfolk, or
- a combination of thereof.

Direct input controls on the number and types of craft, horse power, amount and type of gear, etc., may be effective when enforced with the full cooperation of the fishermen. Without such cooperation, administrative control appears to be prohibitively expensive in widely dispersed artisanal fisheries.

Output controls on amount of catch, in total, for certain target species, or by individual fishermen or vessel, etc., appear to be unenforceable even if the fishermen are cooperative.

From an administrative point of view, economic disincentives in the form of taxes or restrictions on the inputs of fishing (fuel, wood, engines, nylon yarn, interest rate, etc.) are the easiest and cheapest way to prevent overcapitalization. In fact, high interest rates on the informal credit markets and low shore prices through monopsonistic marketing practices may well have prevented any forms of overcapitalization - but were also impediments to the development - in traditional fisheries.

Decisions on types and level of taxes require information on input structure and costs, profitabilities, output structure, fish prices, etc. As taxes tend to be discriminatory in that some fishing methods are more heavily charged than others, care has to be taken on the distributional effects. A policy is also conceivable where some inputs are taxed, while others are subsidized to achieve a change in fishing technology.

Direct methods of limiting or reducing fishing effort in traditional fisheries will in most cases require active participation by the fishermen in the form of democratic decision-making and self-control. Where traditional management practices already exist, these should be preserved and legalized. Information on their functioning may well provide guidelines for the implementation of similar systems in other areas (Christy, 1982 and Panayotou, 1982). However, the creation of democratic community organizations and region-wide fisheries federations, is a lengthy process and cannot be seen in isolation from the generally attained level of democratic consciousness and decision-making in a country.

As can be seen in Appendix 1, decisions on the types of interventions selected for fisheries management may require a range of additional information, particularly on the structure of forward and backward sectors of fishing, on alternative employment potential in the coastal hinterlands, on social and cultural determenants like institutional organization, leadership and decision-making in fishing communities, etc., and on the functioning of traditional management systems.

5. EVALUATION

The evaluation of the efficiency of a selected set of interventions involves several problems:

- difficulty in differentiating the effects induced through an intervention from those which were brought about by other factors;
- time-lag between the introduction of an intervention and the occurrence of benefits;
- difficulty in measuring benefits and costs in the form of qualitative change;
- difficulty in clearly relating general costs of fisheries administration and research to one specific set of interventions.

Measurable benefits can be:

- increase in fishermen's incomes and/or government revenue;
- increase in, or stable employment,
- more equitable income distribution,
- higher or stable catch,
- reduced or stable costs of fishing,
- higher or stable foreign exchange earnings,
- improvement in other social fields (literacy rate, infant mortality, life expectancy, birth rate, intake of protein and calories in percent of requirements, etc.).

Qualitative benefits may be:

- reduction in conflicts between competing groups of fishermen,
- higher political and economic power of fisherfolk,
- change for the better in cultural and social attitudes, values, etc.,
- higher democratic consciousness and participation in decision-making,
- etc.

Measurable costs can occur in the form of:

- additional personnel and material to conduct surveys, process and analyse data,
- technological, biological, economic and social research,
- personnel and material (patrol boats, airplanes, etc.), to control and enforce regulations,
- collection costs of taxes,
- temporary decline in catches, incomes and employment,
- increased seasonal fluctuations in catches, incomes and employment,
- decline in foreign exchange earnings,
- development programmes for the creation of alternative employment opportunities,
- infrastructure costs,
- subsidies,
- social welfare costs.

Qualitive costs may occur in the form of:

- political cost-making decisions on income redistribution, providing rewards for decision-makers to make decisions,
- increased conflicts between competing groups of fishermen,
- change for the worse in cultural and social attitudes, values, etc.,
- social and psychological costs of relocation,
- etc.

A comparison of the measurable costs and benefits which can be clearly attributed to one or a set of interventions will give some indication of the attained efficiency. The final judgement is, however, a political process, in which groups or individuals, will either support or react against the chosen interventions.

The evaluation requires basically all the information collected in the course of monitoring the fishing operations supplemented by additional information on the costs of the interventions.

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APPENDIX 1

Types and Sources of Information Needed for Small-Scale Fisheries Management

Source of information / Information data	Main use	Population census Periodicity 10 or more years	Special fisheries census (frame surveys) periodicity 3-5 years	Sample survey		Village, church, harbour, etc., records (continuing)	Secondary		Statisticsfrom other sectors: agriculture, trade, health, education
				Catch assessment surveys (continuing)	Special survey (irregular)		Research (universities, voluntary organizations)	Company records	
No. of fishing communities	M,E		X						
No. of landing places/harbours	M,E		X						
No. fishing households	M,E	X	X		X	X			
No. of fisher-folk population	M,E	X	X			X			
No. of active fishermen	M,E	X	X		X	X			
- full-time	M,E		X		X	X			
- part time	M,E		X		X	X			
Social indicators (age structure, infant mortality, birth rate, death rate, literacy rate, school enrolment, etc.)	M,I,E	X	X		X				X
No. and types of fishing craft and gear	M,E		X			X			
Investment costs of fishing craft and gear	M,I		X		X			X	

M = Monitoring; I = Intervention; E = Evaluation

Source of information / Information data	Main use	Population census Periodicity 10 or more years	Special fisheries census (frame surveys) periodicity 3-5 years	Sample Survey		Village, church, harbour, etc., records (continuing)	Secondary		Statistics from other sectors: agriculture, trade, health, education
				Catch assessment surveys (continuing)	Special survey (irregular)		Research (universities, voluntary organizations)	Company records	
Prevailing sharing system by fishing method	M,E		X	X					
Operating costs by fishing method and area - fuel - repair and maintenance - ice/baskets - commision/ auction fee - harbour charges - tradition/ taxes, offerings, etc. - others	M,E			X	X			X	
Income and imployment in other coastal activities	I,E		X		X		X		
Marketing and credit system	I,E		X		X		X		
Household expenditure structure	I,E				X		X		
Ownership distribution of fishing craft and gear	M,E		X			X			

Source of information / Information data	Main use	Population census Periodicity 10 or more years	Special fisheries census (frame surveys) periodicity 3-5 years	Sample Survey		Village, church, harbour, etc., records (continuing)	Secondary		Statistics from other sectors: agriculture, trade, health, education
				Catch assessment surveys (continuing)	Special survey irregular		Research (universities, voluntary organizations)	Company Records	
Landings by: - species - area - fishing method	M,E			X					
Value of landings:	M,E			X					
Shore price of important fish species	M,E			X					
Landings per man-hours at sea and per man-hours of fishing - quantity - value - fishing method - area	M,E			X					
Divisible earnings	M,E			X					
Social and cultural determinants: - institutional organizations - leadership and decision-making - family and kinship relation - values, attitudes - etc.	I,E				X		X		
Functioning of traditional management systems	I				X		X		

THE RESEARCH PROCESS AND COMMUNICATION OF RESULTS: LESSONS LEARNED FROM A MULTIDISCIPLINARY ANALYSIS OF A TROPICAL SMALL-SCALE FISHERY[1/]

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1. INTRODUCTION

Along with an increase of their relative share of the total world catch, most tropical countries have experienced in the last decades an expansion of their fisheries research activities. These activities, whether based solely on the funding of national institutions, or on international institutions, multilateral or bilateral cooperative projects, have produced noticeable insights into the nature of the factors which determine fishery yields in the tropics. Yet, the complex nature of the fisheries resources and the overall scarcity of the human resources that have been devoted to applied fisheries research are such that large gaps in our understanding remain concerning tropical fisheries and their management.

In an effort to address some of these questions, the Institute of Fisheries Development and Research (IFDR) of the University of the Philippines in the Visayas and the International Center for Living Aquatic Resources Management (ICLARM) conducted a multidisciplinary investigation of the fisheries of San Miguel Bay in the Bicol region of the Philippines, from 1979 to 1981. Detailed results of this study have been published in several technical reports (see Table 1). In this paper, therefore, we will mainly address the issues of why we did what we did, and how we went about it rather than elaborate on the results obtained. Our aim is to identify an approach generally applicable to the multidisciplinary study of tropical multispecies multigear fisheries, through a presentation of our research process and discussion of lessons learned regarding research methodologies and communication of results.

Table 1

Publications based on San Miguel Bay Project data

Emphasis on	Biology, stock assessment	Economics	Sociology
Methodologies; background paper:	Mines (1982) Mines *et al.* (1982)	Smith, Mines and Beñacia (1982)	Yater (1983a) Bailey (1982a)
Special topics:	Pauly (1982) Cinco (1982) Navaluna (1982) Pauly (1982) Vakily (1982)	Yater, F. (1982) Supanga and Smith (1982) Supanga (1982) Tulay and Smith (1982) Navaluna and Tulay (1982) Cruz (1982) Yater, Esporlas and Smith (1982)	Esporlas (1982) Villafuerte and Bailey (1982) Yater, L. (1982a) Yater, L. (1982) Bailey (1982) Bailey (1982a)
Synthesis of results:	Pauly (1982a)	Smith and Mines (1982)	Bailey (1982a)

1/ ICLARM Contribution No. 142

2. THE LOCATION OF THE STUDY: WHY WE CHOSE SAN MIGUEL BAY

San Miguel Bay, located on the southeastern (Pacific) coast of Luzon Island is one of the major fishing grounds of the Philippines (Figure 1).

The physical characteristics most relevant to the historical expansion of fisheries there are:

- the surrounding area is heavily populated and few non-agricultural employment opportunities exist;
- the Bay, because it is sheltered, is the only fishing ground along the Pacific coast of the Philippines where fishing operations continue throughout the year, in spite of the heavy monsoon winds;
- the Bay is extremely productive, due to its extreme shallowness and to the fact that it is an estuary of the Bicol River whose waters are heavily silt laden; and
- the Bay is highly accessible and is connected by road to Manila, the final destination of a significant part of the catch from the Bay, especially high-valued shrimp.

Because of the physical features of the Bay itself, the fisheries of San Miguel Bay are rather isolated from the surrounding fisheries, thus providing us with a "unit fishery". The estuarine nature of the Bay, moreover, has the effect that the Bay's fish communities are rather easy to separate from the fish communities outside the Bay, which consist predominantly of rocky bottom and coral reef communities. The relatively small amount of interchange between these fauna thus provided us with a more or less homogeneous (multispecies) "unit stock".

The major motive for studying San Miguel Bay, rather than any other fishing ground resulted, however, from our interest in a fishing ground reported to be overfished (Simpson 1978). Also, it was perceived that given the large number of poor fishermen around San Miguel Bay, the primary objective of our study should be to conduct:

> "an in-depth study of the San Miguel Bay fisheries to facilitate this sector's inclusion in the Bicol integrated area development programme, a plan from which fishing communities have been generally excluded". (Maclean 1980, p. 98).

The study was therefore designed to help in deciding what degree of emphasis, if any, should be placed on programmes which encourage the movement of small-scale fishermen into other economic activities. This focus on the possible need for reducing fishing effort was, when it was formulated, in stark contrast to Government policy at that time (1979) which was geared toward fishery development and the provision of loans to fishermen (including those around San Miguel Bay) to facilitate the purchase of improved vessels, engines and gear.

The San Miguel Bay fisheries are exploited with a variety of small-scale gear (such as gillnets and fixed gears) and by a fleet of small trawlers. Under current Philippine law, these trawlers must fish in water deeper than 7 fath. A number of petitions submitted to the President of the Philippines by small-scale fishermen protesting the illegal operation of trawlers in the shallow waters of the Bay provided a certain sense of urgency to our study.

To summarize, we chose San Miguel Bay as the site of a multidisciplinary fishery research project because of:

(i) its importance as a fishing ground;

(ii) its physical characteristics which provided relatively isolated unit stocks and unit fisheries;

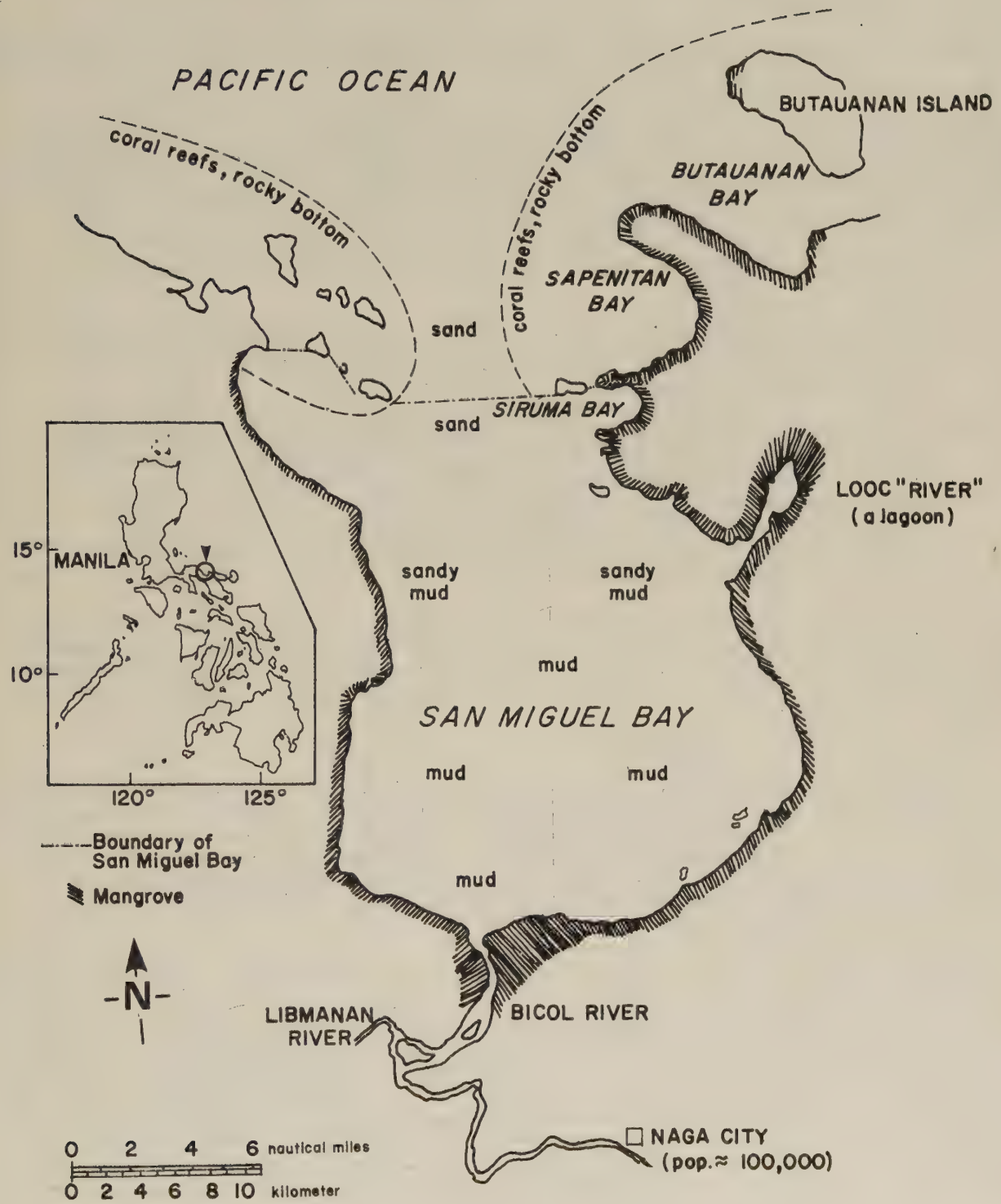


Figure 1 San Miguel Bay, Philippines

(iii) the socio-economic and political relevance of the issues to the area concerned, and

(iv) its potential for serving as a model of multidisciplinary studies of fisheries in the Philippines and elsewhere.

With a broad primary objective related to rural development issues, it was obvious that biological methods (i.e., stock assessment methods *sensu stricto*) alone would be insufficient, and that therefore, other disciplines (fisheries economics, sociology) would have to be involved. The specific objectives for the various disciplines in the study were formulated as follows (Maclean 1980, p.100):

(i) Stock assessment: To assess the status of the fishery resources of San Miguel Bay;

(ii) Economics: To determine catch, effort and incomes of municipal fishermen, costs and returns for the major municipal fishing gears and the economic efficiency of the marketing and distribution system;

(iii) Sociology: To assess the socio-economic development of the six San Miguel Bay municipalities, and to analyse in selected communities, social and external linkages, attitudes and preferences toward fish production, processing and marketing; and to examine the nature of the flow of human resources between municipal fisheries and other rural sectors, and to assess the potential of programmes that seek to reduce the dependence of fishing households on capture fishing.

In the following, an account is given of the methods of data collection and analysis used in the study, and of the reasons for using them (Tables 2,3,4). During the course of the study, our focus shifted from the long-term objective related to rural development to attention on the need and options for fisheries management.

3. STOCK ASSESSMENT DATA AND ANALYSIS

Catch and effort data: It was assessed at the very onset of the project that a primary objective would be to obtain a reliable estimate of present total catch from the Bay, by species group and gear, and every effort was made to achieve this objective. The basic approach used was to estimate the total numbers of every type of gear in use around the Bay, then to estimate catch-per-effort (c/f) by gear by month and species group over a 12-month period, then to multiply effort by the c/f to obtain total catch from the Bay, by gear, month and species group.

Catch per effort by gear was obtained mainly by direct monitoring at selected landing places through a record-keeping activity (see next section on economics). In the case of trawlers, the available fishery statistics as collected by Philippine fisheries agencies were supplemented by data collected by project assistants who made trips on the trawlers at least twice a month for a period of one year. Numbers of the major gears of the fishery (e.g., gillnetters, fixed gears, trawlers) were obtained from counts along the beaches and offshore. These numbers were always much higher than the number of those licensed by fisheries officers or municipal treasurers. Smaller gears (e.g., push nets, handlines) were counted in the course of a household survey conducted by the sociology module of the project. The average effort and catch per effort of these gears were obtained both from recall interviews and by direct monitoring.

The catch estimates by species group obtained by the project personnel for the Bay as a whole (Table 5) were generally 3-4 times higher than those given in official statistics. As discussed in detail (Pauly and Mines 1982), we consider our catch estimates more accurate than those reported in the official statistics.

Historical data: A special effort was made to acquire historical data, i.e., unpublished reports or data collected earlier on the Bay's fisheries by various groups of researchers dating to the 1940s. We had the complete cooperation of the Research Division of the Bureau of Fisheries and Aquatic Resources, which provided data from commercial and

Table 2

San Miguel Bay Project: Major data sources and sampling methodology of "stock assessment module"

Phase		Duration	Data collected	Frequency	Sampling methodology	Sample size
I	a) Catch and effort	2 years	catch, effort and catch/effort data for all gears	continuous	— small-scale fishery: actual gear counts and beachside sampling of catch-per-trip data	very large, i.e., giving c/f on daily basis for some, and on monthly basis for most gears
				continuous	— trawl fishery: sampling on board trawlers, complemented with in-depth analysis of adjusted catch statistics	about 2 trips per month
	b) Length-frequency data	2 years	length-frequency data on 15 different species of fish	continuous	measurement of length-frequency samples on board trawlers	about 2,500 fish measured
II	Bathymetric survey	1 day	present depth contours of San Miguel Bay	once	echosounding of San Miguel Bay with portable echosounder	40% of the Bay's surface area was covered
III	Survey of previous literature and historical data	2 years	list of fish and general hydrography of San Miguel Bay. Reviews estimates of effort and of catch/effort of trawlers. Previous catch composition and anecdotal information on changes in the Bay's fishery	continuous	scanning of all likely sources of primary and secondary data; including files containing unanalyzed data, theses, published and unpublished reports, etc.	not applicable

Table 3

San Miguel Bay Project: Data sources and sampling methodology of "economics module"

Phase		Duration	Data collected	Frequency	Sampling methodology	Sample size
I	Household inventory	3 months	Assets and no. of fishermen per household; sources of financing for owned assets; gears used	Single visit per household in target community	Census of all households in target community	Established sample frame (430 households) for subsequent data collection
II	Landing survey	1 year	Ex-vessel prices of major species. Catch per vessel landing. Number of vessels/gear types landing	3 times weekly at each landing site in target communities	Data collected from all vessels landing through observation and personal interviews of fishermen, wives, and buyers	Varied depending upon number of vessels landing
III	Market price survey	1 year (concurrent with landing survey)	Prices of fresh and processed products in 4 markets	2-3 times weekly	Data collected from all sellers in each market, supplemented by secondary price data of government	Varied depending upon number of sellers in the markets
IV	Costs and earnings record keeping	1 month	Assets, investment costs, life of assets, age and education level of fishermen, sharing system used	Single interview	20% purposive sample (see below) of fishing units in 2 target communities	62 fishing units
		1 year	Catch, operating costs, value of catch per trip/day. Repair and maintenance costs, sharing system modifications	Daily record keeping	20% purposive sample of respondents willing to cooperate	62 fishing units
V	Middlemen and processors cost survey	2 months	Fixed and variable costs, estimated life of fixed assets, daily volume, cost of purchases and receipts, attitudinal data regarding ease of entry	Single recall interview	20-50% random sample of middlemen and processors in target communities	64 firms

Table 4

San Miguel Bay Project: Data sources and sampling methodology of "sociology module"

Phase		Duration	Data collected	Frequency	Sampling methodology	Sample size
I	Community inventory	5 months	Infrastructure, social services, population, no. of fishing households	Single visit to all fishing communities	Key informants interviewed; secondary data from municipalities	Established sample frame for Phase II
II	Socioeconomic survey	7 months	Household characteristics, assets, income, education, attitudes, role of women, sharing systems, marketing practices, occupational and geographic mobility. Physical count of all gears in all communities	Single interview of fishing households	30% sample of fishing households in 22 out of 41 fishing communities; mix of purposive and random sampling	641
III	Participant observation	1-6 months	In-depth information on marketing practices, role of women and children, sharing systems and kinship, occupational and geographic mobility, labor absorption capabilities of other non-fishing sectors.	"Live-in" in single community	Participant observation and in-depth interviews with key informants Examination of census population and migration data	n/a

Table 5

Total annual catch, and trawl fishery and non-trawl catches by taxonomic groups for San Miguel Bay, 1980-81[a/]

Taxonomic group	Total annual catch (t)	Catch (t) by:		% caught by:	
		Trawl fishery	Non-trawl fishery	Trawl fishery	Non-trawl fishery
Sharks and rays	45	36	9	79.9	20.1
Stolephorus spp.	2 100	1 369	731	65.2	34.8
Sardinella spp.	795	201	594	25.3	74.7
Arius thalissinus	44	6	38	13.0	87.0
Mugilidae	1 190	330	860	27.7	72.3
Otolithes ruber	2 004	409	1 595	20.4	79.6
Sciaenidae (excl. *O. ruber*)	1 468	313	1 155	21.3	78.7
Pomadasydae	34	21	13	61.5	38.5
Carangidae	269	57	212	21.3	78.7
Leiognathidae	112	38	74	33.8	66.2
Trichiuridae	324	254	70	78.5	21.5
Scomberomorus commersoni	75	28	47	37.9	62.1
Misc. spp.	4 406	3 018	1 388	68.5	31.5
Squids	250	235	15	93.9	6.1
Crabs	500	120	380	24.0	76.0
Penaeid shrimps	1 044	461	583	44.2	55.8
Balao	4 473	0	4 473	0	100.0
Total catch (excl. balao)	14 660	6 896	7 764	47.1	52.9

a/ Adapted from Pauly (1982a).

research trawlers operating in the Bay. After checking for accurary and standardization, the data were used to demonstrate a steadily declining trend of trawlable biomass in San Miguel Bay, down to 20% of the original biomass in 1947 when the first survey was conducted (Table 6).

We concluded that historical data are highly valuable in stock assessment and that an active search should always be conducted for such data in the course of any stock assessment project.

Length-frequency data: Length-frequency data were collected with two goals in mind: to contrast the size of fish caught by the non-trawl fishery with those of fish caught by the trawl fishery and to estimate growth and mortality parameters of exploited fishes.

To achieve the first of these goals, it was sufficient to collect only a limited amount of data, since it rapidly emerged that generally the trawlers catch much smaller fish than those caught by the non-trawl fishermen.

It was also possible to achieve the second of these goals with a limited amount of length-frequency data because most length-frequency data were obtained on board trawlers, whose gears are only moderately selective, and because the ELEFAN method used for the analysis is not very demanding in terms of data requirements (Pauly and David 1981; Pauly and Ingles 1981).

Yield-per-recruit analyses: As opposed to the situation prevailing in long-lived, single-species stocks of temperate waters, yield-per-recruit analyses conducted on one or several single species of a tropical multispecies stock is generally insufficient to generate meaningful management options for the fishery as a whole, unless short-cut methods are used to assess the impact of a given mesh size on a given multispecies stock, as shown by Sinoda *et al.*(1979). For this reason, in the San Miguel Bay study, we used the yield-per-recruit approach (Beverton and Holt 1957, 1966) only to illustrate relatively minor points, such as the impact of the extremely small meshes used to trawl for anchovies in the Bay.

Biological and oceanographic data: Little emphasis was given in the San Miguel Bay Project to the collection of biological data *per se*. For example, no fish identification programme was conducted because we had no problem with the identification of the important species. However, a list of fishes occurring in trawl catches was compiled, which, combined with San Miguel Bay records from the taxonomic literature, enabled us to compile a list of fishes from San Miguel Bay containing 188 species, 28 of which were new records.

An exhaustive literature search was then conducted of known biological characteristics of those fishes, which enabled us to group the species into various feeding guilds and to build a model of the trophic interrelationships in the Bay, and hence, to assess the potential impact of the selective exploitation of various groups of species on the multispecies stock as a whole. Also, the list of fishes was divided into various groups depending on the reported extent of their euryhalinity, with the result that it was possible to characterize the San Miguel Bay fish fauna as typical estuarine fauna, markedly separated from the hard bottom reef fish fauna off the mouth of the Bay. The species list thus helped us define the multispecies "unit stock" exploited by the San Miguel Bay fishery.

Similarly, very little emphasis was given to the collection of oceanographic or hydrological data. Rather, available secondary data on tidal amplitudes, river discharge into the Bay, rainfall, wind and scattered measurements of salinity were combined, such that a coherent picture of the Bay's water budget emerged, further characterizing the Bay's estuarine properties.

Also, one day was devoted to conducting a bathymetric survey of the Bay, using a simple battery-operated echosounder attached to a fisherman's boat. The results were used to quantify the rate of siltation of the Bay (using the best available nautical chart as reference), which has implications both for the biological productivity of the Bay and to the accessibility of certain parts of the Bay to fixed and mobile gears, hence, to fishery management issues.

Table 6

Estimates of trawlable biomass in San Miguel Bay, 1947-81[a/]

Year		Apparent density (t/km^2)	Trawlable biomass (t)	Number of hauls	Vessels used	Source of data
1947	July	10.6	8 900	5	THEODORE N. GILL	Warfel and Manacop (1950)
1957/58	8 months	5.20	4 370	100	ARCA I, ARCA II	daily reports of a private operator to BFAR Research Division
1967	July	3.91	3 280	2	R/V MAYA MAYA	logbook of R/V MAYA MAYA (BFAR Res. Div.)
1977	September	3.49	2 930	6	"a baby trawl"	Manuscript, BFAR Research Division
1979	July	1.84	1 560	3	F/B GEMMA	Manuscript, BFAR Research Division
1980	February	1.89	1 590	25	F/B SANDEMAN	Manuscript, BFAR Research Division
1980/81	year-round	2.13	I 790	whole fishery	average small trawler	Vakily (1982)

a/ From Pauly (1982a); the biomass estimates are based on standardized catch-per-effort data and application of the swept-area method.

4. ECONOMICS DATA AND ANALYSIS

No previous economic research had been conducted on the San Miguel Bay fisheries; nor were any secondary data on costs, earnings or ex-vessel prices available. Consequently the economic analysis depended entirely on primary data collected during the study.

Cost and earnings: In the study, we gave the highest emphasis to obtaining annual costs and earnings data from a sample of the major trawl and non-trawl gears operating within the Bay.

Initially, through a combination of trip interviews and observation at major landings, we collected data on various gears per fishing trip (costs, value of the catch, fishing location, age and education of major fishermen). We abandoned this approach to costs and earnings, however, when we realized that we could not monitor any particular sample of fishermen in this manner to obtain costs and earnings by individual fishing units over time. For example, if a particular fisherman did not appear at the landing on a given day, we did not know if he had fished with another fishing unit, used a different landing or simply not fished at all. Instead of trip interviews, therefore, we instituted 12 months of record-keeping with a smaller sample (62 fishing units) of the major gears. Landing observations were continued for one year to collect catch, effort and ex-vessel price data.

One may question the usefulness of record-keeping techniques because participants must often be selected non-randomly. However, we believe that it is better to obtain highly reliable data from a smaller sample of respondents selected to approach representativeness than to collect poor quality data from a larger random sample.

The costs and earnings data collected through record-keeping were aggregated manually by research assistants at the end of each month. Although some details were lost in the process, aggregation was especially important for us in the San Miguel Bay study because access to huge computers was both distant and expensive, and because the project's young research assistants could be better trained in the analysis of the data by actually tabulating it using programmable calculators as the project proceeded.

Inventory of fishing assets: The participants in the costs and earnings study were interviewed at the beginning of the record-keeping activity to collect data on investment and fixed costs. Total number of gears operating in the Bay was provided by the sociology module, based on counts in all 41 fishing communities that surround the Bay.

Income of boat owners and crew: As in most small-scale fisheries around the world, income of boat owners and crew are determined by the sharing system for the gear in question. There are many variations on the basic 50-50 sharing system in San Miguel Bay depending upon the gear, fishermen's kinship ties and location. For example, we found that the crewmen of gillnetters in one community in proximity to Naga City, the major commercial centre of the area, had been able to shift the sharing system 60-40 in their favour because of the higher opportunity costs for labour prevailing in that area. The vast majority of the small-scale gears used the 50-50 sharing system however, so fishing income for boat owners and crewmen was determined from the costs and earnings data provided by the record-keeping activity (e.g., as for the gillnetters shown in Figure 2). Pure profit (resource rent) for each gear type was determined by deducting all remaining costs (including opportunity costs of capital and labour) from the respective income shares of owner and crewmen.

The opportunity cost data were particularly important to us because in addition to being a necessary component of costs to compute pure profit or resource rents by gear type, they also provided a basis of comparison of fishing incomes with the next best employment alternatives in the area. The sociology module assisted with the collection of data on income to labour in alternative activities, such as carpentry, piece-work for fish processors, or in the more accessible communities, tricycle driving. Our results showed that the majority of fishermen in the Bay are earning their opportunity costs or slightly more, implying that entry to the fishery will continue. The fact that in absolute terms fishing income is very low simply implies that the opportunity costs of labour are also very low due to the limited non-fishing alternatives in the immediate area; this is confirmed by the sociological studies (see below).

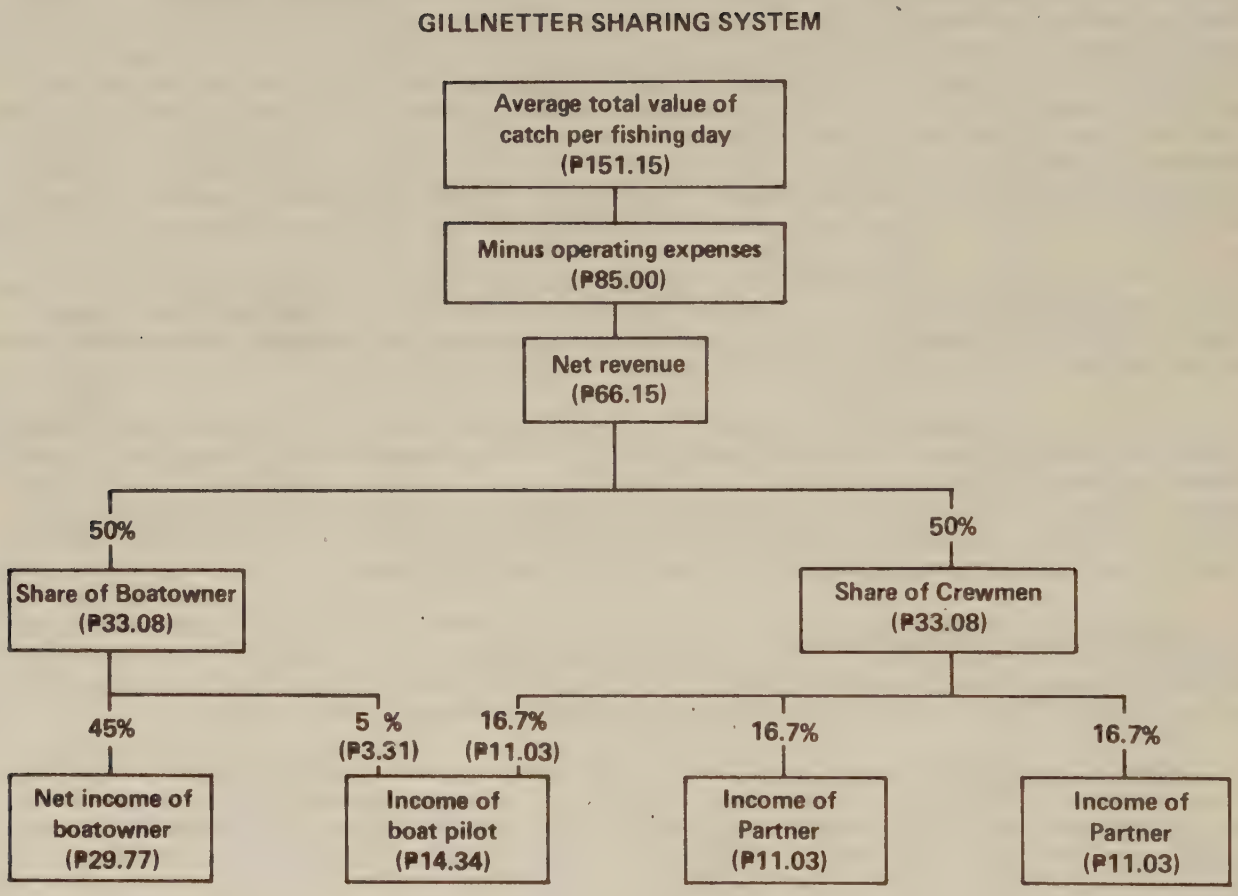


Figure 2 Example of a daily sharing system in San Miguel Bay (gillnetters based on 1980-81 data). Fixed costs and repair and maintenance costs have not been deducted yet from net income of the boat owner

Prices received by fishermen: The landing survey discussed above under "cost and earnings" was the source of ex-vessel price data for the San Miguel Bay study. Because most catch in the Philippines is sold unsorted by volume (a variety of containers is used), collection of accurate ex-vessel price data presented the economics module personnel with more difficulties than any other activity during the 2-year study. We eventually devised a weighting system to estimate prices by major species based on the following information: total value of the transaction; number and weight of containers (we had earlier devised a conversion table of containers to weight); approximate species composition; and relative prices that middlemen would be willing to pay for each species by weight. We could not use the relative prices from nearby markets as a weighting factor because there too, sales are by volume or number of fishes not by weight. This method gave us crude ex-vessel price estimates by major species over the one year that the landing survey was conducted. These data were supplemented by observed prices when particular species were sorted and sold by weight. Unfortunately, this method of sale was less frequently practiced.

To examine the economic efficiency of the marketing sector, we elected to concentrate upon spatial and form price analysis based on data for the major processed and fresh fish from three major landings and three major retail markets. We believe our price data are reasonably accurate and were pleased with the general price relationships which support the hypothesized spatial relationships among markets, though correlation of prices among markets is very low. The observed prices also supported the hypothesized relationships between prices of fresh and processed products, though again correlation was low. Our major problem occurred in the collection of marketing costs because we left this aspect of our work until too late in the project. The marketing survey of processors and middlemen costs was conducted only once at the beginning of the peak season, and covered only the previous day's activities. Though the results demonstrated the expected economies of scale, the same survey should have been repeated at regular intervals through a full year. Where possible, we strongly recommend the inclusion of the marketing sector in record-keeping activities as early as possible in any multidisciplinary study.

5. SOCIOLOGICAL DATA AND ANALYSIS

Primary data: Three techniques were used for collecting primary data: household surveys, interviews of key informants and participant observation. In terms of time and resources spent, the household survey received considerably more emphasis than the participant observation. If we were to do the study again, we would want to bring more of a balance to these two methods and, above all, reduce the number of variables collected through survey techniques. The household survey was designed to serve part of the data needs for the economics, biology and sociology modules; instead, it should have been limited to basic socio-cultural attributes, asset ownership and attitudinal questions. In particular, we found we were unable to make much use of the fishing income and cost data that were collected other than to estimate roughly the percentage of households exclusively dependent upon fishing.

Participant observation, which required the research assistants to live in selected fishing communities for up to one month, produced a rich mosaic of information on the various fishing and marketing activities. In addition to proving educational for the research staff involved, many dimensions of the sharing and marketing systems, for example, would not have been fully appreciated without the information collected using this method.

Secondary data: The most extensive use of secondary data in the sociology module was for the study of occupational and geographical mobility and assessment of income opportunities in local non-fishing activities. Census data of the last four decades, including as yet unpublished data from the most recent (1980) census, were examined. The census survival method was used to determine migration patterns as far down as individual barangays (village administrative units). Supplemented by interviews with families in the San Miguel Bay area, many of whom have family members living elsewhere, the study showed strong outmigration as a response to actual and perceived differentials in economic opportunities. In absolute terms, fishing communities in the San Miguel Bay area still grew at 2.04% per year (1948-80), though less than the national average of 2.71% per year over the same period.

6. MAJOR RESULTS OF THE STUDY

Some of the results obtained through the application of the above described methods were already mentioned. The study's major findings regarding appropriate methods are two-fold. First, our main result is that it appears unnecessary to develop overly sophisticated bio-economic models in the first instance to improve one's understanding of a given fishery. Indeed, given the paucity of high quality time-series data on most tropical fisheries, sophisticated model building would seem to be particularly inappropriate. The important key to a comprehensive research process, it seems to us, is to make clear statements at the onset of the project about manageable objectives and plan how these goals are to be reached by listing data requirements, including quantity and quality, data sources and analysis planned.

A second result is that the simultaneous application of methods from several disciplines lowers the overall costs of data acquisition, and provides extremely useful checks, confirmation and further insights to the findings of any one discipline. The advantages of a multidisciplinary approach can be demonstrated by the following summary presentation of specific research findings.

The stock assessment work, total biomass and single-species methods led to the conclusion that overfishing takes place in the Bay in the sense that further increases of effort will not increase catches. If, as appears likely, increased effort comes in the form of additional trawlers, there will be a transfer of a further proportion of that catch away from the non-trawl fishery (about 3 000 households) to the trawl fishery (about 40 households) (Table 7).

The economic analysis confirmed this competition between non-trawl and trawl gears. The fishery, which is worth approximately P 53 million per year produced a resource rent (pure profit) of only P 3 million (excluding the Government's revenues generated by its taxes on gasoline and diesel) in 1980-81 (Figure 3). Unless entry is limited, expected additions to the trawler fleet will probably completely dissipate this rent in the next few years. Moreover, the present resource rent is distributed very unevenly, with the trawlers earning 85% of the pure profits, while the non-trawl fishery earns the balance. Data on concentration of fishing asset ownership provided by the project sociologists indicated the highly skewed distribution of benefits from the fishery.

The sociological studies, particularly the studies on the occupational and geographical mobility of the San Miguel Bay fishermen, added another dimension to these results by showing that employment opportunities outside the fishing sector are rather poor and that there is a high rate of migration out of fishing communities. This migration, however, is more than offset by population growth so the absolute number of small-scale fishermen will continue to increase.

The Bay can be characterized as having a growing number of fishermen but finite fish resources. Thus, all three disciplines gave the San Miguel Bay fishery the same bill of health; namely that it sorely needs management to address the twin problems of overfishing and inequitable distribution of benefits from the fishery.

7. COMMUNICATION OF MANAGEMENT OPTIONS

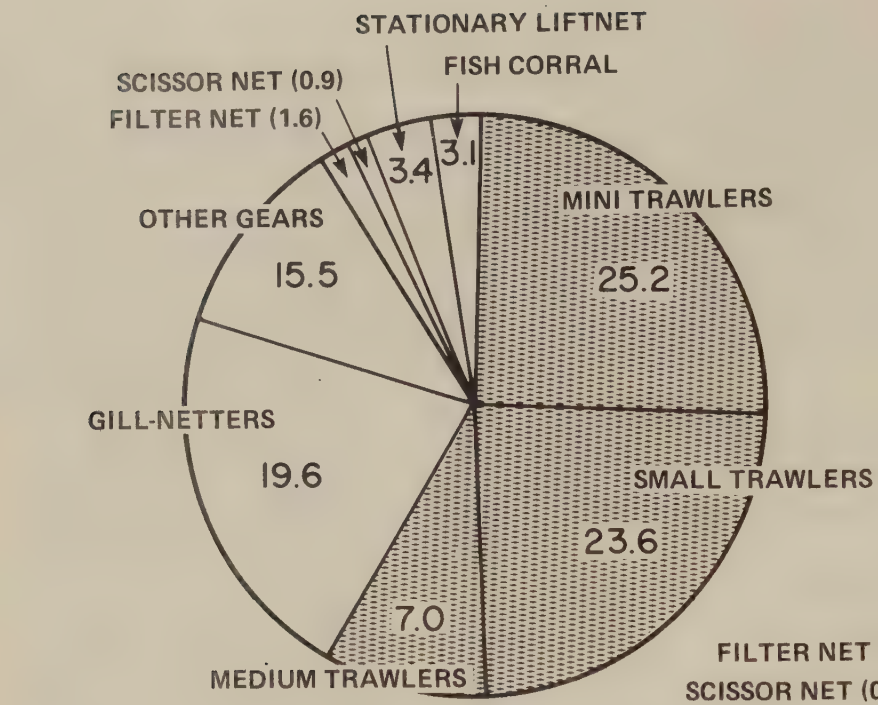
Our initial primary objective was to determine the extent to which the fishing communities of San Miguel Bay can be incorporated into the Bicol region's integrated area development planning. Implied in this objective is the belief that long-term solutions to problems of overfishing in the Bay and low levels of income in fishing communities would lie primarily outside the fisheries sector *per se*. As our research study progressed, however, it became apparent that short-term solutions to these problems could also be sought through management of the Bay's resources and possible redistribution of the prevailing catch and benefits among the competing trawl and non-trawl fisheries. Because the problems uncovered during the course of the study increasingly revolved around issues of equity and income distribution, a sociopolitical dimension was injected into the study. This dimension had not been foreseen when the study was initiated.

Table 7

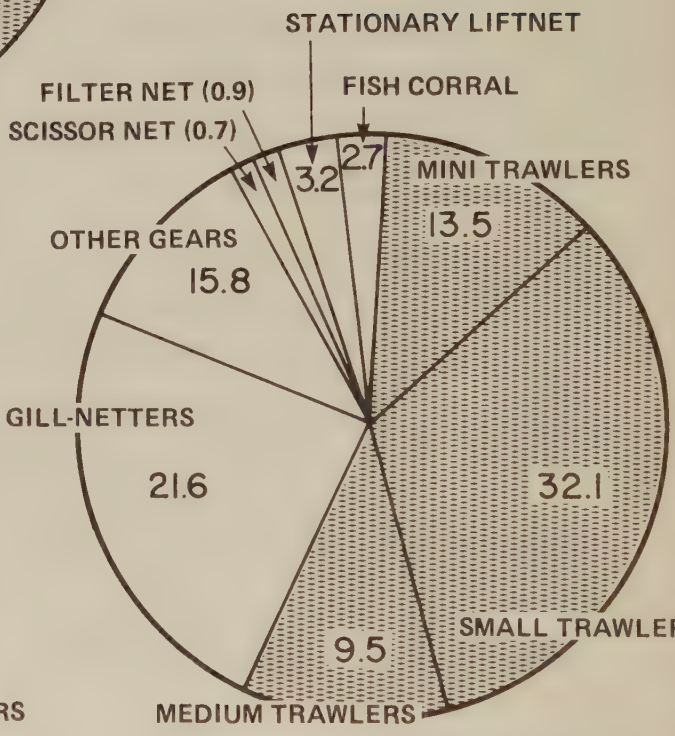
Summary of data on the San Miguel Bay Fishery (1980-81)

Characteristics	Trawl	Non-trawl
Number of fishing units	95	2 300
Number of fishermen	600	5 000
Number of households owning fishing units	40	2 000
Percent of total catch[a/]	56%	44%
Percent of total value	55%	45%
Percent of pure profits (resource rent)	85%	15%

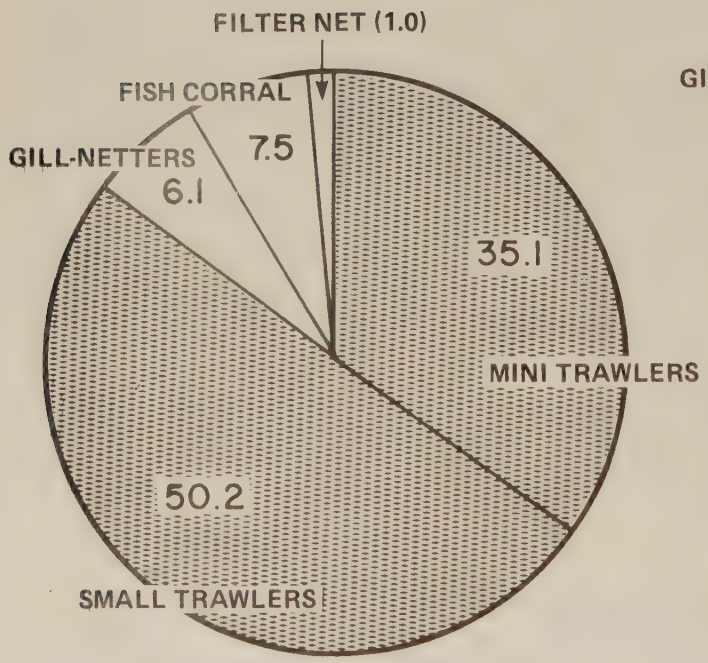
a/ This differs slightly from the percentages in Table 5 because of non-inclusion of balao in Table 5 and slight differences in computation of total catch between the stock assessment and economic modules.



DISTRIBUTION OF TOTAL ANNUAL CATCH (19,000 TONS)



DISTRIBUTION OF TOTAL ANNUAL VALUE OF CATCH (₱53 MILLION)



DISTRIBUTION OF PURE PROFITS (₱3 MILLION)

Figure 3 Distribution of annual total catch, total value of catch and pure profits between different gears and between the trawl (shaded) and the non-trawl fisheries of San Miguel Bay, 1980-81

With this shift in focus as a background, we view the process of communicating the results of the IFDR/ICLARM San Miguel Bay study as containing two distinct elements:

(i) formal communication of technical results to the scientific community; and

(ii) formal and informal communication of the results and their policy implications to fishermen, concerned fisheries agencies and other governmental bodies with jurisdiction over the Bay's fisheries.

The first of these elements can be accomplished quite readily through publication of technical reports and wide dissemination of these both within the Philippines and elsewhere. Commenting upon the need for such communication may seem unnecessary, but unfortunately, the number of fisheries projects worldwide that produce extremely limited documentation is distressingly high. Table 1 gives a listing of the formal publications produced during the IFDR/ICLARM study.

The second element of communicating research results is much more problematic for several reasons. The first problem facing fisheries researchers is that all too often no one is listening. Failure to integrate research findings with development planning is common, and the researcher is often faced with the uphill task of having to wait until the research is completed before being able to convince the fisheries planners of the usefulness of such integration. This is especially the case when the study has been conducted by a university-based group, as was the case with our San Miguel Bay study.

A second aspect of this lack of integration of research and planning is that research is seldom seen as part of the necessary continuing process of data collection and analysis required for rational management of fisheries. Most tropical countries concentrate their statistics collection efforts upon catch and possibly prices, and are thus a long way from appreciating the value of management-oriented research. Researchers themselves contribute to this problem with their concentration upon partial analyses, whether biological or socio-economic, that stop short of evaluating management options. Indeed, our initial primary objective for the San Miguel Bay project led us away from a more productive working relationship with the local fisheries office; instead we were in contact primarily with the regional development planning body which has no explicit role in fisheries management.

A third problem facing researchers regarding communication of their results is that they are often expected by fisheries agencies to come up with a list of recommendations on what should be done by way of follow up. If the researcher is examining a narrow issue such as vessel or gear efficiency, then recommendations for improvement may be appropriate. In the case of studies as broad as the IFDR/ICLARM San Miguel Bay study, however, where the major issues are those of overfishing and inequity, it is unreasonable to expect researchers to make explicit recommendations. This is because any action that redistributes income should be the result of a political process, a process that should not be pre-empted by the researcher.

Fisheries management thus contains an inherent political element. Our approach in the San Miguel Bay study has been to outline management options and present the likely trade-offs of each. In this sense, we are letting our findings "speak for themselves". A combination of: (1) written reports; (2) seminars with appropriate fisheries agencies, municipal and provincial officials; and (3) translation of research results into more popular forms of communication such as audio-visuals and magazine-type articles has been (or will be) undertaken.

It is obvious from our research results that managing the Bay's resources will require some limitation on fishing effort. Failure to do so will not only contribute to further overfishing, but will also exacerbate the already inequitable distribution of benefits from the fishery between the trawl and non-trawl sectors. This leads to a final problem that relates to the problem mentioned above regarding the integration of research with planning. Possibly the best way of reaching this integration would be to set up a permanent body (e.g., involving fishermen representatives, the Bureau of Fisheries and Aquatic Resources and the municipalities concerned) with clear prerogatives and tasks - one of which should be the continuation of information gathering.

8. CONCLUSION

The cooperation of fishermen will be necessary if reliable catch, effort, costs and returns data are to be collected on a continuous basis, and cooperation of trawler operators is unlikely if they believe their participation in the fishery is threatened. Communication of research results to fishermen and obtaining their support for management should be a function of a management organization; in the absence of such an organization as was the case in San Miguel Bay, these tasks fell upon the researchers who conducted the study, and from our experience, it is unreasonable to expect reseachers to perform these tasks. The success of a continuing research programme for a particular fishery and the usefulness of its results will thus depend in great measure upon the support of an effective fisheries management programme.

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A BRIEF REVIEW OF BRAZILIAN NEAR-SHORE FISHERIES

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1. INTRODUCTION

The management of Brazilian fishing resources is directed chiefly towards a few selected species pink shrimps, sardines, demersal fish, tuna and related fish, lobsters etc... which are subjected to relatively intense industrial fishing. These account for approximately 40% of the national yield (Anon. 1974).

The systematic collection of catch and fishing effort data has been limited mainly to these species as have the applications of stock assessment models in order to monitor the fisheries through quantitative studies.

The near-shore resources have received less attention, and are only a few fisheries from which suitable data for quantitative anlysis are available. The seabob shrimp fishery in the Southern and Southeastern regions of Brazil and the "Piramutaba" fishery in the mouth of Amazon river are the leading examples.

Except for those which concern shrimps in nursery areas, the other coastal fisheries have rarely been monitored. The only available data is of the total landings, which is not always reliable.

Some qualitative control measures have been applied in regional areas. Among these are the establishment of minimum landing sizes, closed areas or seasons, and the regulation of mesh size. However there are no objective appraisals concerning the state of those stocks, or, in the case of fishing in nursery areas, no guarantee as to the possible relationships between the juvenile population and the adult stock.

In some cases, management and regulation measures have been applied to avoid conflicts between fishermen due to the overlap of different types of fishing gear operating in the same fishing area.

This report records some near-shore fisheries situations, assessments, when available, and management measures which have been adopted.

2. FISHERY IN THE TUTÓIA AREA - MARANHÃO

Tutóia is situated in the state of Maranhão in NE Brazil (2°43'S and 42°15'W).

The dominant coastal area bottom is sand with isolated pockets of mud which are directly due to the influence of coastal rivers. In the eastern area of this region, at the Rio Parnaíba delta, there are large mangrove areas which are presently being intensely harvesting for timber.

The fishery is basically artisanal, and concentrates on white shrimps (*Penaeus schmitti*) and pink shrimps (*Penaeus subtilis*). The gears used are basically very simple. They are called "redes de lance" and puçás".

The "rede de lance" (a kind of beach seine) is made of nylon, and is 200 m long. Its ends are tied to stakes and this forms the net mouth when pulled and secured. At the net mouth the mesh size is 3 cm between knots and the net height is 2.40 m. The wings, which make up the middle section, display meshes with sizes ranging from 1.0 to 1.5 cm between knots and the net height ranges from 3.2 to 4.80 m. At the codend, the mesh diameter is less than 1 cm and the net height reaches 5.60 m. The rope is pulled by the fishermen and is about 500 m long at both ends of the net. The catch operation is quite simple. It is performed by seven men. The net is situated in the boat and is thrown out gradually, while the vessel describes a semi-circular path, and throughout this procedure a man on the shore holds the rope. This takes about 10 min, and when completed, the other fishermen

haul the ropes into the shore. The whole operation can be performed in 30 min by three men at each end of the rope and the last man looking after the boat.

On the average, the fishing consists of eight sets and the catch is stored in the boat.

The "puçá" is a simple trawl net pulled by two men in shallow waters. Its average dimensions are:

mouth height	- 1.50 m
width	- 3.00 m
body length	- 5.00 m
codend length	- 1.00 m

The mesh size is 1.0 cm in the body of the net and less than 1.00 cm at the codend (measured between knots).

Besides shrimps, a few other valuable commercial species are caught. They are principally catfish (*Tachysurus* spp.), "pescadas" (*Cynoscion* spp.) and "pescadinha" (*Macrodon ancylodon*). All of these fish are consumed locally.

The total shrimp production in Tutóia's artisanal fishery reportedly reached 116 t in 1975, 350 t in 1976 and 500 t in 1977. These figures probably underestimated the true landings due to the large number of landing points and the difficulty in collecting data.

The number of fishermen employed in the years quoted above are 1 400, 1 600 and 1 800 respectively. The total number of registered nets in 1977 was 97 seine nets and 1 400 trawl nets.

The Industrial Fishery

The industrial catch is carried out by otter trawls (double rig) which operate from the Amazon River to the Tutóia area. Sometimes the trawlers operate close to the mouth of the Tutóia Bay and come into contact with the artisanal fishermen and damage their driftnets. In order to avoid this problem, SUDEPE (Superintendency of Fishery Development, Ministry of Agriculture) has forbidden otter trawlers to operate South of the 2°35'S parallel, about 10 mi from the coast.

Assessment and Resource Management

The pink shrimp stock has been systematically appraised and mannaged using information on catch and fishing effort, and length frequency distribution obtained from the industrial fleet.

There are no analyses of the interrelationship between adult stock in oceanic areas and juvenile population exploited in the Tutóia region.

There are also no regulations controlling or limiting the artisanal fishery in the area.

3. FISHERY OF "PIRAMUTABA" IN THE NORTHERN REGION OF BRAZIL

The "Piramutaba" (*Brachyplatystoma vaillanti*) is a catfish (order Siluriformes), found in almost all of the clayish water rivers of the Amazon basin, in the northern region of Brazil.

The "Piramutaba" is subjected to intensive fishing by both artisanal and industrial vessels. The main catch comes from the estuary region formed by the Amazon and Pará Rivers.

The artisanal fishery has been carried out since at least the beginning of the century, whereas the industrial fleet only started in 1971. Almost all the fish landed by the industrial fleet is preserved frozen for export.

The following table gives the landings for both fisheries since 1972 (in tons), and also the fishing effort by the industrial fishery:

Year	Artisanal fisheries landings	Industrial fisheries	
		Landings	Days at sea
1972	2 911	5 440	1 424
1973	4 772	8 559	2 191
1974	3 227	13 930	4 096
1975	2 978	16 305	4 344
1976	5 249	16 679	4 300
1977	6 271	22 486	4 086
1978	4 939	17 506	4 100
1979	4 139	16 576	4 890
1980	3 852	14 004	6 100

Though smaller than the industrial catch, the artisanal catches are still vitally important to the regional economy as all the fish caught is consumed - salted or fresh - by the local population.

The main fishing areas for the artisanal fishery in the State of Parã are in the vicinity of Marajõ Islands (00°30'S and 48°30'W).

The fishing gear commonly used in this fishery are "malhadeira", longline and "curral". The "malhadeira" is a kind of gillnet which operates on the river bottom. It has a length of between 100 and 2 000 fath and a height of between 2 and 3 fath. The mesh size is 6-10 cm between knots.

The common types of longline vary in length between 100 and 300 fath with the minimum number of between 200 and 300 hooks. The secondary lines have hooks which are adjusted to fish near the bottom.

The "curral" is basically a fixed entrapment gear, and whilst the design varies greatly according to the disposition of the enclosures, the materials used in its construction tend to be wood, bamboo or vine. On the average, the length tends to be about 20-50 m with a height of 5-6 m.

Nowadays the gillnets yield 150-250 kg of fish for a fishing period of 2-3 h. Longline fishery currently yields 50-100 kg in an average fishing period of 2 h. The productivity of "currals" is subject to seasonal variations and the average fishing period is 3 h. The fishing operation is carried out from the beginning to the middle of ebb-tide period. A few years ago the catch had reached 3 t when the conditions were favourable (high tides), however, the current yields are much lower.

The fishing gears are carried by a variety of sail boats or boats with small engines.

There is another artisanal fishery in the main body of the Amazon River which concentrates on the "piramutaba" as they migrate upstream from the mouth of the river. The fishermen use seine nets which are either operated from the banks of the river or held between two canoes. SUDEPE only started monitoring the catches in 1979, when the total landings reached 1 373 t. The 1980 landings were 1 062 t.

The industrial fishery is restricted to the mouth of the Amazon River in front of Marajõ Islands and is bounded by Cabo Maguari (00°15'N and 48°25'W), and Cabo Norte (01°42'S and 49°55'W). The fleet operates up to a distance of 80 mi offshore in depth ranging between 3 and 20 mi.

There are three main features which characterize the fishing area: the presence of an extensive layer of sediments carried down by the river and deposited at its mouth; a gradual and regularly sloping bottom; and a very high level of turbidity which gradually decreases away from the shore.

At first, the catch was carried out by shrimp boats using a double-rig system. Due to strong currents and the sheer weight of the catch per set, bottom pair trawling was introduced. The fishing time varies from 2 to 4 h according to the abundance of fish in a given period or area.

Today there are 66 vessels operating in the area with an average age of 7.5 years and an average crew of 7. The boats have engines of 165-565 hp and are about 16-27 m long. They may be from about 29 to 152 GRT.

Between 1975 and 1979, the "Piramutaba" constituted about 90% of the total industrial landings. This went down to 84% in 1980. The other species in the catch, are from *Brachyplatystoma* spp. and *Tachysurus* spp.

For the industrial market all "Piramutaba" which fall below a certain specified size are discarded at sea. The percentage descarded varies according to the time of year and reaches a maximum between April and October. In 1979 and 1980 the percentages rejected were 21.8% and 9.9% respectively.

Assessment

The application of Schaefer's model to the landing and fishing effort data, produced a value for the maximum sustainable yield of 20 900 t and a corresponding maximum fishing effort of 5 900 days at sea.

The 1980 fishing effort was more than the effort corresponding to the MSY and there was a reduction in total catch.

The main problem in the use of the production model for "Piramutaba" fishery is the shortage of information regarding the real catch (including the reject percentage). Also, the catches only contain fish which were not fully mature, from which it appears that the area fished is only representative of a section of the whole stock.

The patterns of landing and fishing effort data indicate that the fished stock is probably in an advanced state of exploitation. This fact could be due not only to the level of effort applied, but also to the high catches of small fish which result from the current fishing pattern.

No specific analyses have been carried out on the interaction between artisanal and industrial fishing.

Management

Industrial trawl fishing was initially concentrated close to the coast at the mouths of the Amazon and Para Rivers, practically in the same area already exploited by the artisanal fleet. This overlap of the two types of fishing resulted in a series of accidents and caused the destruction of gillnets. As there is also a marked concentration of small fish in this area, SUDEPE has prohibited otter trawling in the region between 00°5'N parallel and 48°00'W meridian. This reduced the number of accidents, and also the discard percentage.

In order to contain the growth in fishing effort the industrial fleet was, at first, limited to 56 boats. This number was subsequently increased to 66. The rejection problem was also reduced by the introduction of legislation governing the mesh size. As a result of net selectivity experiments a minimum mesh size of 100 mm between knots (stretched length) was enforced on the fleet. Using nets of this mesh size the mean selection length is 27.4 cm.

More recent management recommendations suggest a further reduction in fishing effort and the effective prohibition of the use of nets with a mesh size less than 100 mm.

There are no control measures applied to artisanal fishing.

4. FISHERY OF THE SEABOB SHRIMP

The seabob shrimp (*Xiphopenaeus kroyeri*) is abundant on the Brazilian coastline. It tends to disappear only towards the south of Santa Catarina (27°26'S and 48°26'W). It is found in shallow coastal waters which either have mud or a combination of mud and sandy bottoms. The principal catch is in the southern and southeastern areas of the country in the vicinity of the States of Espírito Santo, São Paulo, Rio de Janeiro, Paraná and Santa Catarina.

In general, the catch is made using the variety of small boats which are generally less than 12 m long and have engines of between 8 and 15 hp. The boats operate with otter trawls which have headropes that have a maximum length of 12 m and a minimum mesh size of 15-20 mm between knots. The catch is carried out during the day, with the fleet leaving in the early hours and returning before sunset.

The current fleet consists of approximately 2 500 boats and is broken down in the following manner:

Rio de Janeiro	- 850
São Paulo	- 350
Santa Catarina	- 500
Paraná	- 500
Espírito Santo	- 300

Since 1972, larger boats have been introduced along the São Paulo and Paraná coasts. These use the double-rig system but, as yet, represent a very small proportion of the active fleet.

The main output of the fishery is the seabob shrimp, but quantities of white shrimps (*Penaeus schmitti*), pink shrimp (*P. brasiliensis* and *P. paulensis*) and fish, such as the "pescadinha" (*Macrodon ancylodon*), croaker (*Micropogonias furnieri*), other "pescadas" (*Cynoscion* spp.) and sharks are also caught. The proportion of each group varies according to the region and the time of the year. Unfortunately, there is no available data on the amount of fish yielded or the specific composition.

Assessment

In the absence of further information on species behaviour in its areas of occurrence, the southern and southeastern areas are considered to contain only one stock for the purposes of evaluation.

The statistics of catch (since 1965), and effort (1 000 h of trawling available since 1972) are as follows:

Year	Catch (t)	Effort ('000 h)	Year	Catch (t)	Effort ('000 h)
1965	1 395	-	1974	10 920	309.4
1966	2 689	-	1975	9 911	345.5
1967	3 898	-	1976	10 320	405.8
1968	4 817	-	1977	13 505	637.0
1969	6 879	-	1978	14 641	581.0
1970	8 812	-	1979	14 893	528.1
1971	8 530	-	1980	14 594	621.0
1972	10 944	224.7	1981	15 536	636.7
1973	13 954	314.4			

Schaefer's model has been fitted to these data, giving an estimate of maximum sustainable yield of 14 160 t corresponding to a maximum effort of 570.07 x 10^3 h of trawling.

The effort has exceeded this in the last few years, and it is evident that the stock is heavily fished.

No modifications have been made for either the changes in fishing power during the last few years or the variation in catch efficiency due to the introduction of boats equipped with double-rig system. Adjustments for these changes would increase the estimate of effort in recent years.

Management

SUDEPE has the trawling fleet to the number in active service at the beginning of 1979 and has forbidden the use of additional boats in the area between the 23°20'S and 30°00'S parallels.

The states of Espírito Santo and Rio de Janeiro have not been included in the above limitations as the artisanal fleets do not solely exploit seabob shrimp. Even at the southern tip of the state of Rio de Janeiro, where the seabob shrimp stock is being extensively exploited, the Government has considered the withdrawal of grants and financial assistance enough of a deterrence to limit the growth of the fleet.

Other management measures have been introduced to protect shrimp stocks and also the coastal fishery which is basically an artisanal activity. These vary slightly according to local conditions in the various states.

In the State of Rio de Janeiro boats more than 5 GRT that use otter trawl have been forbidden to fish in depths of less than 15 m. (All the bay areas have their specific regulations.) In São Paulo, trawl fishing is not permitted by boats of more than 5 GRT in areas which are less than 1.5 mi from the coast. In Paraná and Santa Catarina the net length has been limited to a maximum of 15 m and the headrope length to a maximum of 12 m. No vessel is allowed to operate with more than one net. Also in Santa Catarina, boats of more than 5 GRT have been forbidden to trawl in areas that are closer than 1 mi from the coast.

5. FISHERY OF THE NORTHERN AREA OF THE STATE OF RIO DE JANEIRO

The fishing area in the North of the State of Rio de Janeiro is concentrated in 5 small locations. There are about 750 small boats in operation and they concentrate almost entirely on shrimps of the following species.

- "Barba Ruça" shrimp (*Artemesia longinaris*)
- Seabob shrimp (*Xiphopenaeus kroyeri*) and
- "Santana" shrimp (*Pleoticus muelleri*)

The area consitutes one of the poorest in the State, and the modernization process began little more than 10 years ago. Until then, the fleet consisted of vessels with no engines which were only able to operate in a very limited area. As a result, the productivity was found to be very low. The locality which contains almost half of the active fleet does not even have anchorage facilities and, therefore, the boats have to unload direclty on the beach after they have managed to master the breaking waves. This process is generally tractor-assisted. There are also no adequate conservation facilities and no well-organized system of commerce.

The boats range from 8 to 12 m in length and generally have 18 hp engines. The hold capacity varies from 1 to 5 t.

The equipment used for the shrimp catch is the stern otter trawl. The nets are about 15 m long and the crew generally constists of 2 or 3 men. The catch is made within 5 mi

of the coast where the depth of the water does not exceed 10 m and the bottom is generally sandy and dominated by seaweed.

Besides the shrimp catch, there is a fishery which focuses on fish, using anchor and drift gillnets. Hence, sharks, "pescadas" (*Cynoscion* spp.) and croakers are caught.

There is also a developing catch which concentrates on the "pargo" (*Pagrus pagrus*), and this is carried out by handlines. Boats equipped with longline are used in the capture of sharks. All of these constitute about 100 boats and they operate in deeper water (55 m) than the shrimp trawlers.

Assessment and Management

The local fishing has yielded the following production figures during the last four years (in tons):

	1978	1979	1980	1981
White shrimp	1	0.9	0.1	0.4
Seabob shrimp	508	1 023	719	527
"Barba ruça" shrimp	895	334	2 001	1 642
"Santana" shrimp	126	126	263	129

In the case of "pescadas" and sharks, the production figures for the last two years are as follows (in tons):

	1980	1981
"Pescadas"	357	62
Sharks	101	87

There is no detailed information about the fleet productivity and catch and fishing effort, as the only data available are taken from the statistics of total landings. A very small number of fishermen fill in fishery log sheets after each trip. These data on catch and effort are considered together with those from south and southeast regions for seabob shrimp stock appraisal.

There have been no attempts to assess the current state of the fishery or to establish potential yields.

According to local information, the fishery is still in an early stage of development.

The Government is therefore stimulating the purchase of new boats and fishing gear through direct financial assistance to fishermen and has even lifted the restrictions on seabob shrimp fishing which were adopted elsewhere. In order to further develop the area, the Government is also building a harbour with modern landing and fish storage facilities.

In the course of shrimp fishing there is a substantial by-product of a range of other fish, such as rays, juveniles of "pescadinha" (*Macrodon ancylodon*) and other fish of low commercial value, and a large amount of seaweed (*Stypopodium* sp., *Cryptonemia* sp. and *Laminaria* sp.). There is however no detailed information available on the catch composition, percentage of each species and total discards. The only fish which are consumed and sold are the "pescadas" and croakers.

6. ARTISANAL FISHERY FOR SHRIMP IN THE LAGOA DE ARARUAMA - RIO DE JANEIRO

Lagoa de Araruama is a large shallow estuary situated between the cities of Cabo Frio and Araruama (22°49' - 22°57'S and 42°00' - 42°44'W). Its maximum depth is 14 m, but more

than half the Lagoon has a depth of 2 m or less. The Lagoa is broken into a series of relatively isolated areas by seven long thin peninsulas, and is isolated from the sea by a narrow sandy strip on its southern extremity. A narrow channel connects the Lagoa to the sea. The water is hypersaline and a large proportion of the shoreline is occupied by salt evaporating pans. The bottom segment is almost entirely calcareous, being covered by deep deposits of the valves of small bivalve molluscs.

The fishery for pink shrimp (*Penaeus brasiliensis*) in the Lagoa de Araruama has been carried out on an artisanal basis for at least 50 years. The quality of shrimp landed and sold by fishermen is given below:

Year	Landings (t)	Year	Landings (t)
1965	268	1972	312
1966	443	1973	303
1967	606	1974	194
1968	719	1975	203
1969	744	1976	196
1970	630	1977	271
1971	423		

These values are underestimated as they do not include shrimp not sold through local markets or shrimp used for private consumption by the fishermen and their families. It was not possible to estimate the percentage not registered but it seems to have been considerable.

Unfortunately the collection of shrimp landing data was discontinued in 1977 and there is therefore no information available for recent years.

Fishing Gears

Several types of artisanal fishing gears are used: "ganchos" are fixed traps with a long wing or shaft set perpendicularly to the shore or across tidal currents. They are constructed of nylon webbing stretched between wooden stakes driven into the bottom of the lagoon. The mesh size of the webbing used varies from 20 to 26 mm (stretched length).

Approximately 180 of these traps existed in 1974 in the Lagoa with the majority located towards its centre. In addition, there were 44 larger "ganchos" directed to catch fish, principally mullet.

"Barragens" are fixed funnel-shaped nets stretched between two wooden stakes driven into the ground. They are set across channels on the outgoing tide between the last quarter and new phases of the moon. The mesh sizes of these nets vary from 20 to 26 mm (between knots). The number of nets used is about 26.

"Arrastos de dois calões" are simple trawl nets, usually about 12 m in headrope length, that have a wooden stake attached to each wing. These stakes need two fishermen to drag the net along the bottom in shallow water. The mesh size used varies between 10 and 12 mm (between knots). There are about 85 of these nets operating in the whole area.

"Troias" are seine nets used by four men working from a canoe. They vary in length from 50 to 90 m and are constructed of nylon mesh with 10-12 mm between knots. These nets are designed to fish in depths of up to 2.5 m. Canoes are used to reach the fishing areas and several hauls are made during each night fished. Fishermen use stilts to fish in deeper water. There are about 85 "troias" in activity. Fishing is carried out principally between 6.00 and 12.00 p.m.

In 1974 the total number of fishermen fishing solely for pink shrimp was estimated to be 900-1 000.

Fishing Areas

The lagoon can be divided in three separate areas, based on its bathimetry, distribution of sediment types and salinity regimes. Each of them has its own dominant types of fishing gear.

The first area is formed by the channel that connects the lagoon to the sea and a small basin. It is subject to a strong tidal influence and consequently the salinities are not greatly increased by evaporation. The extensive shallows are covered by dense beds of algae and sea grass which trap considerable amounts of fine sediment and detritus. These beds seem to be of great importance for the settlement of post-larvae in the lagoon. The shallow parts of this area are fished by "arrastos" and "barragens".

The second area is formed by the first large basin of the lagoon and is connected to the interior of the lagoon by a relatively narrow channel. The bottom sediment consists of the valves of mulluscs, covered with finer sediments, algae and seagrass. Salinity varies markedly with the tide but in general falls between the high salinities of the inner part of the lagoon and the almost normal sea conditions of the first area. The dominant fishing gears in this area are seine nets.

The third area comprises the remainder of the lagoon and is characterized by high salinities and a calcareous bottom. Tides have little effect in this area. Shrimp are caught with entrapment gears, but in rather smaller amounts than in the previous areas. The main bulk of the catch is composed of large shrimps (mean about 9 cm total length).

Assessment

From 1972 to 1976 there was a decrease in registred production. This drop suggested a fall in shrimp abundance, as local information stated that the number of fishermen had increased and that the quantities consumed locally were at least the same. The small amount of data available on landings per unit of fishing effort showed the same trend: 1970:11.4 (kg per trawl-night); 1971:13; 1972:9.8; 1973:7.4 and 1974:6.6. During the same period there has been a contraction of the areas of shrimp abundance from the interior of the lagoon towards the entrance channel at Cabo Frio.

Fishermen reported that after 1970 there was a marked intensification of fishing in both the first and the second areas of the lagoon and that before this ocurred the catches from the third area were far higher than the present day. This reduction in catch was probably provoked by the capture of pre-recruits in the first two lagoon areas and/or by the marked increase in dredging and filling within the entrance channel, causing its occlusion and the reduction of sea water penetration to the interior of the lagoon.

Some attempts were made to study growth and migration patterns of shrimp in the lagoon but almost nothing was done either to evaluate fishing effects on shrimp nursery area populations or to estimate potential catches.

Management

The fishery for shrimp in the Lagoa de Araruama was, theoretically, regulated by a law prohibiting catching of shrimp of less than 8 cm total length; the use of certain types of fishing gear and the use of mesh sizes less than 30 mm (stretched lengths). If the local fishermen were forced to catch only legal size shrimp, serious economic and social consequences would result because only a small proportion of the shrimp reaches 8 cm total length before leaving the lagoon. In order to avoid this kind of problem a set of specific management measures were proposed to regulate the shrimp fishery. These proposals would have been adopted on an experimental basis in an attempt to re-populate and re-develop the fishery in the inner area of the lagoon.

The measures were: to prohibit the use of trawl-type nets in the first area of the lagoon, including the entrance channel. Fishing in that area was only to be carried out by use of stake nets. Restrictions were imposed on their spatial distribution in order not to block the channels completely.

- to prohibit the use of seine-nets (troias) in the second area, preserving it for fishing with simple trawl-nets. "Troias", due to their higher catching efficiency, were supposed to be more suitable for the fishery in the third area;

- to prohibit the use of entrapment nets ("ganchos") in the channels or basins of the first and second areas. Because of their small mesh which readily clogged with floating weed, they seem to impede water flow and migration of juvenile shrimp within the areas.

Although those regulations have been made official by SUDEPE, they were never really adopted because of the lack of adequate policing in the area.

7. FISHERY IN THE BAIA DE SEPETIBA - RIO DE JANEIRO

The Bay of Sepetiba is situated in the east of the state of Rio de Janeiro (22°53'S to 23°04'S and 43°30'W to 44°00'W). This occupies an area of 470 km^2. Although there are areas in which its depth reaches about 30 m, 40% of the Bay has a depth less than 5 m. The Bay is fed by several small rivers and canals. It has a muddy bottom and it is surrounded by practically untouched mangroves on its northern and eastern boundaries.

The main resources of the Bay are comprised of white shrimps (*Penaeus schmitti*), croakers (*Micropogonias furnieri*), catfish (*Tachysurus* spp.), mullets (*Mugil* spp.), "pescadas" (*Cynoscion leiarchus*, *C. petranus*) and pescadinhas (*Macrodon ancylodon*).

Until 1975, the same nets (entrapment and gillnets) were used to catch both shrimp and other types of fish. Since then small boats with stern otter trawls started being introduced. In 1976, the total number of boats reached 80. Currently the number of active boats in the fleet oscilates between 100 and 200 with about 180 fishermen. The boats are from 2 to 12 GRT. The majority of them are less than 7 t (95%). The engines have an average power of 50 hp.

The trawlers are responsible for more than 90% of the shrimp catch and about 14% of other species which are caught in the Bay. The entrapment gears and gillnets are still in use to catch many types of fish, and are operated by 395 canoes and about 1 200 fishermen.

When examining the ownership of trawlers, it was found that the boats were concentrated in the hands of a small number of people with 33% of the owners having 60% of the authorized fleet. In certain cases, it was found that a single fisherman owned six boats, or more.

Between 1976 and 1980 the white shrimp catch yielded the following figures (in kg):

1976	145 111
1977	128 809
1978	168 259
1979	150 147
1980	196 955

It was found that the fixed gear shrimp catch declined steadily during the same period and went down from 23 087 kg in 1976 to 11 098 kg in 1979. All other species gave a total yield (in kg) of:

1977	286 191
1978	344 678
1979	385 449
1980	403 134

In 1979 and 1980 a more extensive data bank was available and it was therefore possible to compare and analyse catches of the main species made by boats carrying different sets of equipment (kg).

	Trawl		Fixed gear	
1979	1979	1980[a/]	1979	1980[a/]
White shrimps	139 049	143 032	11 098	-
Croaker	8 765	-	70 660	67 793
"Pescadas"	4 080	3 919	17 631	34 624
Mullet	-	-	78 043	71 408
Mixed species	18 890	27 911	24 553	25 204
Catfish	-	-	58 881	71 453

a/ June-September only

An analysis of other species caught showed that the only types that were common were croaker and the "pescadas".

However, systematic exploratory surveys of the area show that the actual proportion of the total catch which is constituted by white shrimp is about 5% and the majority of the catch is made up of fish which either have no commercial value or are too small to be sold.

Croaker and "pescadas" (basically *Macrodon ancylodon*) on average constitute 1% and 1.5% respectively of the total catch. Surveys show that about 50% of the above species caught are less than 15 cm long.

Between 1977 and 1979 the carapace length of the average caught shrimp in the Bay went down from 29.15 to 24.2 mm and the correspondence total length from 13.6 to 11.7 cm.

During the sampling programme, no shrimp of less than 8.0 cm TL was recorded.

Assesment

Catch and fishing effort information is only available for the three years between 1977 and 1979 and the respective catch per hour statistics are as follows:

1.68 kg in 1977

1.43 kg in 1978

1.87 kg in 1979

These figures were extrapolated from the fishery log sheets completed at the end of each trip. Despite the fact that the above procedure was theoretically compulsory, lack of inspection led to the abandonment of the system due to insufficient data. The number of boats which actually used the register were considered too few to yield significant information.

No assessment model has been applied to the existing data and nothing is known about the interaction of the shrimp stock in the bay, with other possible stocks in oceanic waters.

Management

Trawl fishing had been forbidden in the bay until 1976 when it was regulated.

The fleet was then limited to 88 vessels which were actively operating at the time. This was adopted as a means to restrict any possible growth of fishing effort. It is clear from the previous information that the number of boats fishing without permission approximates almost exactly to above figure.

Trawl fishing is permitted in areas where the depth is more than 6 m.

There is a long standing underlying conflict between the two groups of fishermen in the area. The fishermen that use gillnets and other fixed gear maintain that trawl fishing is a predatory activity as these kinds of nets land juveniles of important, commercially valuable species, besides the fact that they wreck their own fixed nets during the course of night time fishing.

It is believed that the decrease of the average size shrimp might have contributed significantly to the fall in productivity as fixed gear fishing deals predominantly in large shrimp.

There has also been a marked reduction in the catch of "pescadinha" (*Macrodon ancylodon*) and this has been attributed to the large number of young fish destroyed by the trawling operation.

The proposed measures for regulating the fishing in the bay have not yet been adopted. The general philosophy behind the measures relies on the limitation of the fleet to existing levels, the maintenance of the area forbidden to trawlers and the protection of the fixed gears by prohibiting trawl fishing between 18.00 h and 05.00 h.

8. FISHERY OF "MANJUBA" IN THE REGION OF RIBEIRA DO IGUAPE RIVER - STATE OF SÃO PAULO

"Manjuba" (*Anchoviella lepidentostole*) is an engraulid fish found abundantly in the estuarine area of Ribeira de Iguape River (24°40'S and 47°25'W) situated in the south of the State of São Paulo. It occurs throughout the marine, estuarine and freshwater environments at different stages of its life history.

The total registered yield for the past five years is (in t):

1977	2 289
1978	2 808
1979	3 446
1980	1 732
1981	1 653 (until october)

There are about 500 fishermen operating at the mouth of the river and a further 1 400 operating along the main body of the river.

Seine nets are usually used and yield up to 2 t per set. Other nets are used which combine the seine effect with the drift resulting from the effect of the flood tide. These nets have a smaller productivity yielding between 100 and 200 kg per set. The nets operate in mid-water and their length and height vary according to the depth and width of the river. The mesh size is 10 mm between knots and the operation is conducted by canoes with a crew of about 6 or 7 fishermen.

The yield is generally sold to small factories where it is salted and dryed and the fish are usually consumed locally or in the surrounding area.

Assessment and Management

As in the previous cases no quantitative assessment has been attempted and nothing is known about the way the stock disperses along the coast. The biology and dynamics of the species as well as its migratory patterns have as yet not been clearly established.

Sand banks have formed along the length of the river close to its mouth which have had the effect of decreasing the width. As a result, a long and narrow channel has been created which links the main body of the river to the sea. The migrating schools have therefore been funnelled into the channel causing a very high concentration of fish, naturally resulting in a large number of fishermen operating in a very small area.

In order to guarantee the passage of migrating fish from the sea, SUDEPE introduced certain legislative measures, despite the fact that little is known about the effect of of this concentration of effort on the fishing mortality rate.

It was also thought that fishing in the channel could seriously affect the productivity of the fishermen operating along the main length of the river, and so, SUDEPE has put a total ban on fishing along the length of the channel. They allowed the fishermen operating in the rest of the estuary area to fish freely with nets of a minimum mesh size of 24 mm (stretched length).

9. SHRIMP FISHERY OF LAGOA DOS PATOS

The Lagoa dos Patos is situated in the State of Rio Grande do Sul and runs parallel to the coast between 30°20'S and 32°10'S. The estuarine part of the lagoon has a long and narrow mouth with high hydrodinamic and abrupt salinity variations. Despite their low amplitudes, the tides have their levels increased by winds. Variations in the mean level occur seasonally during the winter months, due to prolonged floods, which inundate the marginal marshes. Due to frequent penetration of saline waters, the water level is low and the salinity is high, during the summer. The sediments up to 1.5 m depth are sandy and the percentage of silt and clay increases according to depth.

The interaction of salt and fresh water occurs in the estuary region below the 31°50' parallel, but the fishing of pink shrimp (*Penaeus paulensis*) is only carried out further south were the lagoon meets the sea.

Despite a marked yearly variation the yields are considerable and are tabulated as follows:

Year	Landing (t)	Year	Landing (t)
1964	1 569	1973	566
1965	5 844	1974	4 903
1966	648	1975	1 997
1967	772	1976	1 997
1968	5 531	1977	1 625
1969	4 807	1978	3 701
1970	4 978	1979	7 824
1971	5 812	1980	2 397
1972	8 221	1981	1 078

The fishing season is from December to July with maximum yields occurring between January and May. The shrimps are caught during the course of their migration through the channel towards the sea. The types of gear used are stake net barriers and manually operated towing nets (small trawl nets pulled by two fishermen).

There is no information available as to the evolution of fishing effort in the region but the number of fishermen employed is currently known to be about 14 000. After July the fishermen turn their attention to other types of fish such as mullet (*Mugil* sp.), croaker (*Micropogonias furnieri*) and catfish (*Netuma barba*).

Assessment and Management

Unfortunately due to the lack of sufficient data no assessment of the pink shrimp stock in the area could be made. Also no attempts have been made to analyse the effects of the artisanal fishery on the adult stocks in the oceanic areas.

Despite the fact that there are large yields of juvenile shrimps in the Lagoa dos Patos, there are not any notable catches of adult shrimps off the coast of Rio Grande do Sul. Research suveys have been carried out in order to investigate the migration pattern along the coast. Adult shrimps were caught all along the area examined but the shrimps were never found in commercial quantities. It is thought that these shrimps are migrating further north and are incorportated in the adult stock to be found off the State of Santa Catarina coast.

Despite the fact that the destination of the migrating shrimps is not known, a number of qualitative measures have been adopted to preserve the stock. More recent legislation limits the fishing season to end in April and prohibits the catch of shrimps less than 90 mm long (total length). The minimum allowable mesh size is now 12 mm between knots and the rows of fixed nets can only be placed at intervals of 300 m (minimum). The number of fixed gear per fisherman has been limited to a maximum of 40 and the number of nets per boat has been limited to four. Except for manually operated trawl nets, all kinds of trawl fishing have been completely prohibited in the Lagoa.

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FISHERIES RESEARCH AND MANAGEMENT STRATEGIES IN NIGERIA: A CASE STUDY

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1. INTRODUCTION

Nigeria has a sandy and sand-with-mud, often surf-beaten, 800 km (approximately) coastline with continental shelf widening from about 14 km in the west to 45 km in the east. This narrow shelf and adjoining extensive brackish waters, respectively, support an industrial trawl fishery and an artisanal fishery of set, drift, or encircling gillnets, hooks, and traps.

The main industrial fishery, consisting of 10-30 m LOA trawlers, has been exploiting the multispecies demersal finfishes in the inshore area since the late 1950s. The trawlers rarely operate beyond the 80 m isobath, concentrating on suprathermocline species. Principal among these are *Pseudotolithus typus, P. senegalensis, P. elongatus, P. brachygrathus, Cynoglossus* spp., *Polydacytlus quadrifilis, Arius* spp., *Caranx* spp., and *Dentex* spp. Also caught are *Brachydeuterus auritus* and semi-pelagics including *Ilisha africana.*

Double-rigged Mexican-type 24-m boats shrimping in the Niger Delta and to the east constitute a second major component of the industrial trawl fishery. They resulted from the joint ventures established in the late 1960s. The target of this export-oriented fishery is the pink shrimp, *Penaeus r. notialis = Penaeus duorarum notialis.* Considerable quantities of the shallow water shrimp *Parapeneopsis atlantica* are also trawled. Incidental to shrimping is a large by-catch of small-sized fishes including species exploited by the fishing trawlers.

The artisanal fishery using canoes 3-13 m long, 10-15% of which are at present motorized, has been in existence much longer. The artisanal fishermen exploit essentially the same (aforementioned) fish and shrimp species as well as juvenile shrimps including *Paleamon hastatus* in the immediate coastal and brackish waters. They also harvest seasonally the clupeids *Ethmalosa fimbriata* between the eastern border and the Benin River area and *Sardinella maderensis* to the west. *Ilisha africana,* another clupeid, is also fished in addition to particularly large-sized specimens of *Megalops atlantica, Arius* sp., *Polydactylus quadrifilis* and *Pseudotolithus* spp. There is, therefore, some overlap among the three main national fishing interests.

Nigeria, whose southernmost point is about 4°N above the equator in the central Atlantic, claimed a 200-n mi EEZ in 1978. Early indications by the 1963-65 Guinea trawling survey (Williams, 1968) suggested that this extreme eastern corner of the central Atlantic is not particularly rich in fish resources and that the component species are short-lived. Considering that the potential of the stocks was most probably moderate at best, management was thought to be crucial. It was also realized that early management measures have better chance of fuller compliance.

2. OBJECTIVES OF MANAGEMENT

The foregoing and the prevailing circumstances in Nigeria, viz., high population density the Sahelian drought which has resulted in dwindling livestock production, protein deficiency, the enormous importation of stockfish and low quality frozen fish, show the importance of fish and fisheries in the national economy. To increase and maintain high local fish production at lowest costs were set as the overall goal of fisheries development and management. Other objectives include the maintenance of full social benefits through increased employment, enhanced fisherman's socio-economic status, better fish utilization as food, and the minimization of conflict between different fishery interests.

3. FISHERIES RESEARCH STRATEGIES

A prerequisite for fisheries management is research to collect and analyse biological and statistical data for the assessment of the stock size and to establish an index of mortality. Time series of data are vital in monitoring changes in stock characteristics in response to changes in fishing effort over time. Usually, accurate and detailed data and other parameters from which the potential yield, for example, is derived using the classical models, take time to collect. These are, therefore, long term. However, management measures emanating from easier-to-collect, shorter time series of data can also be effective and less expensive to monitor and enforce. In any case, some management is much better than a total lack of regulatory measures.

The strategy in Nigeria emphasizes simple but informative data, inexpensive to collect, in preference to highly precise data generated from more sophisticated facilities and equipment. Data routinely collected concentrate on the temporal and spatial abundance and distribution of stocks, species composition and interaction, age structure and length relationship, growth, spawning, size at first maturity, juveniles, especially of shrimps, and trends in biomass. Interviews, particularly with artisanal fishermen, have also proved useful in providing baseline information quickly.

Research priorities are set based on the immediate problems without necessarily losing sight of the long term. This is in preference to attacking all facets simultaneously and spreading the limited facilities and capability too thin to achieve timely and useful results.

Mandatory pre-exploitation surveys are a management strategy. Surveys are repeated annually to monitor the changes. The swept-area method is used to estimate the biomass. The data on species composition and catch rates according to depth, stratum, and season obtained from the pre-exploitation surveys provide the preliminary estimates of abundance in time and space on which the decision to go ahead or otherwise rests. They also determine the level of initial investment and guide its general direction. The licensing policy, size, and number of boats is also a by-product of the surveys. Exploratory and demonstration surveys for tuna stocks in the Nigerian EEZ, as well as the demersal fishes in the 50-200-m zone, are currently in progress.

The Guinea trawling survey (Williams, 1968) and the Nigerian trawl survey (Longhurst, 1965), among others, provided the bases for the establishment of the inshore demersal trawl fishery. Several surveys, including Raitt and Niven (1969), FAO (1969), Bayagbona *et al.* (1971) and Bayagbona (1979) preceded the commercialization of shrimping activities.

In spite of these precautionary measures, commercial statistics and the length frequencies analyses (mean and modal lengths) showed that the fish stocks were being depleted even before further management measures could be introduced. The trawlers had concentrated on the proven 5-30 m fishing grounds in the immediate vicinity of the port of Lagos from where the entire fleet operated. Essentially, then, only a fraction of the available space was being exploited. A series of experimentations on the selectivity of various codend mesh sizes was commenced in 1958. This led to the determination of a codend stretched mesh size whose 50% selection factor permitted the escape of prespawning recruits of the target species. The codend mesh size regulations were then proposed and the Sea Fisheries Mesh Regulations were eventually introduced in 1971. They proscribed a stretched codend mesh size less than 76 mm for fish and 44 mm for shrimps.

Recent research studies have shown that the mesh regulations were effective and that the target stocks have benefitted. The incidence of large-sized croakers, *Pseudotolithus typus* and *P. senegalensis*, increased while their modal sizes in the fishery increased from the preregulation 18 cm to 27 cm subsequent to the regulation.

The multispecies nature of the stocks has, however, complicated the problems because the 76 mm does not protect all species equally. It, in fact, does overprotect some species to the extent that all but a few large individuals escape capture. The reverse is true of the 44-mm codend mesh size for shrimps which retains very small individuals of non-commercial and commercial species. Researchers have estimated that 44% of the total catches of shrimpers are fish in this category, usually less than 18 cm in total length.

The situation is recently further accentuated by boats who take a license for shrimping but apparently target on fish while using a 44-mm mesh size. Unfortunately, using the landings, it is almost impossible to establish beyond reasonable doubt whether a boat has been fishing for fish or shrimping. The solutions to these problems are the subject of ongoing research.

More research attention was focused on the industrial fisheries as they were expanding faster than the artisanal fisheries and were therefore more in urgent need of management. Research in relation to artisanal fisheries was mainly directed towards improving its efficiency. Experiments demonstrated conclusively that synthetic monofilament gillnets were superior to multifilament natural fiber nets. These were then introduced with the correct mounting ratio. It would appear from the foregoing that fishes exploited by the multi-gear artisanal fisheries, the industrial finfish demersal fisheries, and the fish by-catches of shrimpers are much the same species. However, Longhurst (1964, 1965) did state that the fish off the Niger Delta are smaller than their counterpart of the same species elsewhere on the Nigerian coast. Does this imply that there are:

(a) three stocks of fish - the west central and east of the delta,

(b) two stocks - deltaic and elsewhere, and

(c) one stock with stunting of those in the delta?

Initial tests using electrophoresis suggested one stock. They should, therefore, be managed as one stock. This necessitates that there should be one estimate of the stock potential. There are difficulties here. Collection of the catch statistics is a big job because of the scattered landing sites. The units of effort of the artisanal canoe gillnet fishery on the one hand and the industrial fish and shrimp trawlers on the other are difficult to reconcile and standardize. None appears to truly reflect the abundance and none is a particularly reliable measure of fishing mortality. So long as the industrial boats cannot trawl close inshore, their catches are not going to reflect the true abundance of some commercial length classes. The gillnets of the artisanal fishermen have their bias too, and their unit of effort is less precise. Inspite of this, using Schaefer's global model (considering among others the multispecies fishery) and the historical data for the Lagos fishing ground and then applying a raising factor based on the area, an MSY for the inshore trawl fishery was predicted (Ajayi, 1982).

Longhurst (1965) had obtained information to the effect that the productivities of different areas in the inshore fishing grounds were comparable. Similar computations were done to predict a potential for shrimps. However, while the problems of the reliable unit of effort remains, it is acceptable to increase the efficiency of production. Research was also conducted into beach landing canoe types capable of riding the surf and crossing sand bars to make longer forays into the sea. Improved processing techniques (smoking) for bonga *Ethmalosa fimbriata* and *Sardinella* spp. to reduce spoilage and increase shelf life were also investigated to maximize artisanal fishery production. It is however possible to add up the independent estimates of the potential of each of the components. Previous addition of component estimates suggests that this procedure may not be grossly in error as evidenced in the case for Atlantic tunas.

In any case, the artisanals still have little exploited "virgin" areas to accommodate further expansion while the industrial finfish fishery now exploits the entire ground. It is, therefore, useful to set a target beyond which no industrial catch increases can be expected.

The interpretations of the MSY computations indicate that the finfish fishery can still expand somewhat while the shrimp fishery is now fully exploited. This is in agreement with conclusions from surveys.

4. MANAGEMENT MEASURES

A consequence of the pre-exploitation and other surveys was the rationally planned pace of fisheries development and controlled growth of the industrial inshore demersal trawl fishery (through the licensing policy). This was deliberate so that development

and growth do not run the full hog and take their toll before management measures are proposed and implemented. The number of mistakes, usually irreversible, are, in the process, minimized. As an incentive to encourage pre-exploitation surveys, gear and equipment for such surveys are imported tax free while foreign partners are exempt from other restrictions. A by-product of the surveys is a licensing policy which at the moment specifies, among others, the size (LOA and GRT) of the vessels to be used for fish or shrimps in the continental shelf and beyond, respectively. This is an indirect control of the effort.

A major management approach resulting in a direct increase in fish production is the diversion of attention to unexploited or moderately exploited stocks away from fully exploited stocks. This emanates from the surveys. In this regard ongoing surveys of the 50-200 m zone will lead to fuller exploitation and to tuna fishing.

The selectivity experiments formed the basis of the codend mesh size regulations. These legislated a minimum stretched codend mesh size for fish and shrimp, respectively. They also stipulated that at least 75% of the landing of a shrimper must be fish. This is to encourage the landing of the fish by-catch which would normally have been discarded to provide cold storage room for shrimps. Discard obviously should have no place in a situation where food is in short supply. It is definitely uneconomic to harvest prematurely. Unfortunately, the distribution of shrimps is not so delimited as to preclude the capture of undersized fish, yet a shrimp fishery is desirable. License fees have, therefore, had to be low to encourage rather than discourage entry. The motive behind this licensing policy as a management tool now appears outdated, especially with respect to shrimping which is now fully exploited.

Management aims to discourage the introduction of gear that are so vacuum-cleaning efficient as to be harmful. Also entrenched in the Nigerian fisheries organizational setup are regular and *ad hoc* meetings and dialogue between the various groups responsible for fisheries - planners, developers, managers, research and university personnel - to exchange ideas and disseminate information. The National Fisheries Development Committee and the Fisheries Society of Nigeria call annual meetings and sponsor seminars to discuss selected nagging issues.

Management of the artisanal fisheries has been perhaps the most elusive. Fortunately, its growth has been slow, owing to the economic situation of its operators - the local fishermen. Government guaranteed bank loans, readily available to their industrial fishery counterparts, are not readily granted to them because they lack the securities. Recent government intervention has therefore been chiefly directed toward upgrading these fisheries, for example through the introduction of surf-riding reinforced glass fiber canoes, gear, and outboard motors at 50% subsidized costs. Port, fishing, and marketing infrastructure and facilities, including slipways, ice and storage spaces, are also being provided to increase and maximize production through the use of the appropriate fishing and marketing techniques. Inboard motor, shallow draft boats, researched and designed to cross sand bars, are also being tested for much the same reason. Some management measures are directed at the artisanal fisheries. For obvious reasons, the use of poisons - synthetic (cocoa insecticide concentrates) and natural (originating from plants - *Tephrosia* spp.) - is prohibited, as well as the use of explosives.

That the artisanal and industrial fisheries exploit essentially the same species group in overlapping fishing grounds does cause some clashes of interest. The management measure to stem these conflicts reserves the first two nautical miles of the coastal waters for the artisanal fisheries activities. This non-trawling zone is, therefore, permanently closed to the industrial fishermen. This area, however, includes part of their traditional inshore shallow-water grounds known to harbour extra large individuals usually in breeding conditions. Violations are, therefore, not infrequent and are often accompanied by the destruction of gillnets set overnight by the artisanal fishermen. It has been proposed to increase the non-trawling zone from 2 to the first 3 or 5 nautical miles of the coast depending on how productive the 50-200 m area, currently being surveyed, proves. This will give the spawning stocks some respite and persuade the industrial fishery to exploit deeper waters.

Enforcement of fisheries management measures is as difficult in the Nigerian setting as in other places. The numerous scattered landing sites do not make enforcement particularly easy. The fisheries inspectors are the everyday link between the industry and the

establishment, especially in those remote landing sites. They, of necessity, have to win the confidence of the fishermen. They usually cannot turn round to police simultaneously. Cost of enforcement, too, has to be balanced against the benefit.

5. CURRENT OR PLANNED RESEARCH AND MANAGEMENT PROPOSALS

Current or planned research studies are to form the basis for proposals to supplement the existing management tools. The shrimp fishery has to be managed as a stock that is fully exploited. To shrimp below Fmax, allowing for estimation bias, new entrants to the fishery should be discouraged through very high license fees and generally stiffer licensing conditions. New boats should be licensed only when they are replacing old ones of similar capacity. Efforts to eliminate poaching, if successful, can be rewarded by licensing local ones to replace them. It appears that there have always been as many poachers as are authorized.

The short and long-term implications of increasing the shrimp codend mesh size from a minimum of 44 mm to 60 mm are being analysed. If and when this is effected, undersized fish will escape and the attraction to violate the shrimp license by targeting on fish will be reduced. Research into a shrimp and fish separator net is also planned.

The use of chafers has been reexamined. It is true that they protect the belly of the net from wear and tear. However, they are usually too coarse, small meshed, and constructed right round, hugging the codend, thus reducing the effective mesh. It is proposed that legislation, when passed, would limit the mesh and thickness of the material while specifying that chafers hang loosely on the belly only. The alternative is to ban chafers completely. A minimum landed size for each species fixed at the 50% retention length could also be imposed to advantage. Penalties for violation are at present out of date. It is proposed that they be raised to make them prohibitive.

The introduction of the compulsory logbook as part of the licensing condition for shrimp and fish trawlers is to be put forward to government. Free licensing of the artisanal boats in inland waters has been suggested (Ita,1982). It is a matter of extending this to the coastal areas although there will be initial problems. The ultimate advantage of this to data collection and management is not in doubt. Frame surveys of the artisanal fisheries have been part and parcel of data collection. Its costs militate against its frequency. However, the review of the raising factors in the years between surveys is now regular. Management is currently emphasizing local and overseas training for all categories of personnel concerned with fisheries, including enumerators and other field staff to improve capability. The dissemination of research findings is yet to be streamlined. Career prospects of university and research institute staff are enhanced by publishing in foreign academic journals. This is naturally attractive to fishery scientists even though the readership of these journals in Nigeria, where the information is certainly more relevant, is nil. The Fisheries Society of Nigeria is addressing itself to this problem.

If the proposed regulatory measures are found workable and fisheries planning, development, research, and management continue to march hand in hand, the basis for rational fisheries exploitation in Nigeria would have been established.

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M-43
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